Coal Age

1955

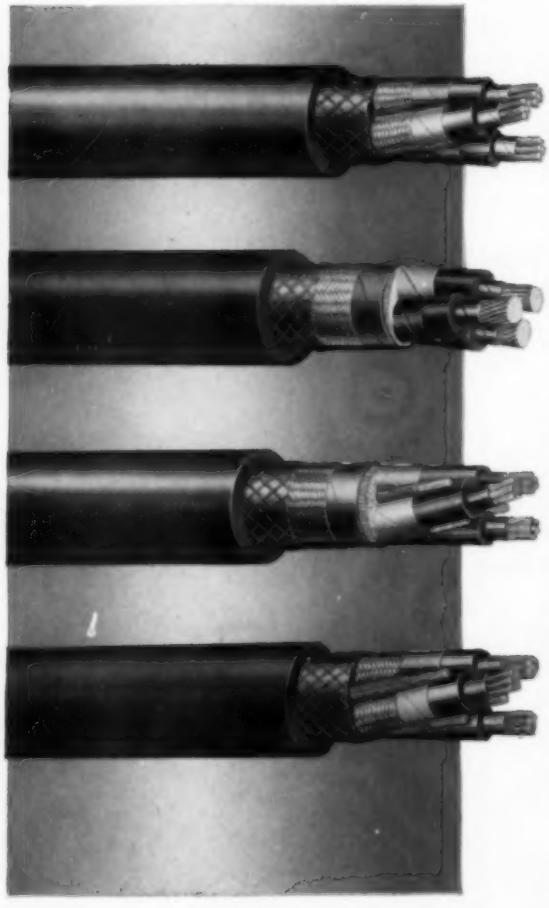
MINING GUIDEBOOK

AND BUYING DIRECTORY ISSUE

MID-SEPTEMBER, 1955 A McGRAW-HILL PUBLICATION PRICE 50¢

Avoid costly "Downtime" with U. S. Royal Shielded Portable Power Cables

Shielded Portable Power Cables, Type SH, are preferred (or generally used) for the distribution of power to portable equipment at voltages above 2000. Shielded cables provide greater protection to the insulation and are safer to handle than other types of portable cables. These cables are of the four types listed below. Where maximum safety is desired, type SH-D cables are recommended.



U. S. Royal SH-A Cables consist of three or four flexible coated annealed copper conductors covered with a semi-conducting tape. Each conductor is insulated with U. S Uskorona-1 oil base compound, and covered with colored tapes and a braided coated copper shield. The conductors are then cabled and covered with a reinforced jacket of 60% black neoprene. The shielded braid over each insulated conductor eliminates corona cutting by static discharge through equalization of surface stresses.

SH-B cables consist of three or four flexible coated annealed copper conductors covered with a semi-conducting tape. Each conductor is insulated with U. S. Uskorona-1 oil base compound plus colored tapes. Conductors are then cabled with jute fillers, covered with a rubber-filled tape, a braided coated copper shield and reinforced 60% black neoprene jacket. The shielding braid protects the men handling the cable in the event of fault currents.

SH-C cables consist of three or four flexible coated annealed copper conductors covered with a semi-conducting tape. Each conductor is insulated with U. S. Uskorona-1 oil base compound and covered with a colored tape. The conductors are cabled with jute fillers and with the specified fabric-covered ground wires in the conductor interstices; then covered with a rubber-filled tape, braided coated copper shield and a reinforced 60% black neoprene jacket. This allows grounding of equipment and provides an adequate low-resistance path for short circuits, thus insuring circuit breaker operation. The grounded equipment provides protection to workmen under fault conditions.

SH-D cables consist of three or four flexible coated annealed copper conductors covered with a semi-conducting tape. Each conductor is insulated with U. S. Uskorona-1 oil base compound and covered with a colored tape and a braided coated copper shield. The conductors, together with fabric-covered grounding conductors, are cabled and covered with a reinforced black 60% neoprene jacket. The conductor shielding, when properly grounded, equalizes surface stresses and draws off all capacity charging currents, insuring safety in handling. An adequate low-resistance ground for the equipment is provided by the grounding conductors.

All shields and grounding conductors, when used, should be properly and thoroughly grounded.

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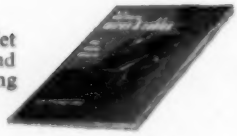

UNITED STATES RUBBER COMPANY
ELECTRICAL WIRE AND CABLE DEPARTMENT, ROCKEFELLER CENTER, NEW YORK 20, N. Y.

US RUBBER

The Coal Age Mining Guidebook . . .

A New Coal-Mining Service

What It Is

THREE-WAY HELP in solving mining problems and achieving the necessary cost, quality and safety standards so essential for mining progress is the goal in the compilation of this Mining Guidebook and Buying Directory Issue of *Coal Age*, designed for continuing reference in checking, developing and revising mining practices, and purchasing equipment, materials and services. It is the first in an annual series, and the three main sections were organized to provide these three services:

1. **Practical down-to-earth, up-to-date and continuously useful data** on basic principles, modern practice, and modern equipment and materials for cutting costs, raising product quality and promoting safety in both deep and strip mining.

2. **Special data on equipment, materials and services** for modern mining. In this section, the manufacturers present key information on the products, materials and services they offer the coal-mining industry.

3. **Where to buy equipment, materials and services.** Arranged by products and including trade names, this buying directory is designed to facilitate the location and purchase of equipment, materials and services by conveniently arranged listings of who offers what and where they can be found.

Who It's For

THE COAL AGE MINING GUIDEBOOK AND BUYING DIRECTORY is designed for all men—organization heads, operating officials, engineers and designers, and electrical, mechanical, preparation, maintenance and safety men—involved in coal production, preparation, safety and related activities, including the purchase and use of equipment, materials and services.

Face foremen interested in improving face haulage, as an example, will find a discussion of basic principles and modern practice under "Transportation" in the Deep-Mining Guidebook. Organization heads, operating officials and maintenance men, deep and strip, interested in improving their maintenance setup will find a separate Guidebook devoted to this subject. And of course the what, where and how of machine application—and the results that can be attained—run through the entire Mining Guidebook, with the Buying Directory and manufacturers' pages handy as a reference in purchases—not only of equipment but also of materials and services.

How to Use It

CHECKING MINING PRINCIPLES AND PRACTICES—What the six main divisions of the Mining Guidebook are and where they appear is shown in the general index, which can be found by turning the page. Detailed indexes on the material appearing in each division precede each such division and permit rapid locating of the material on specific topics, such as, pitch operation in deep mining, haulage in strip mining, dewatering and drying in preparation, and so on.

BUYING EQUIPMENT, SERVICES AND MATERIALS—For locating the makers of, for example, wire rope, vibrating screens and lubricants, check the appropriate product classifications in the Buying Directory, beginning on p 197, and consult the data provided by the manufacturers in the advertising section.

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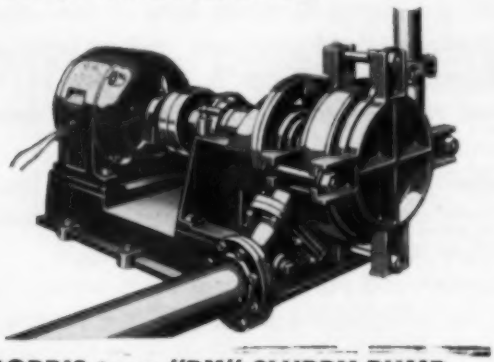

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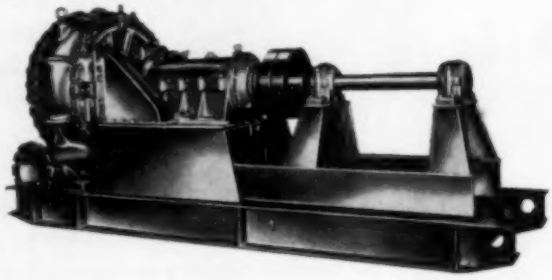

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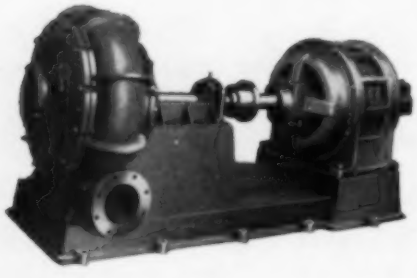

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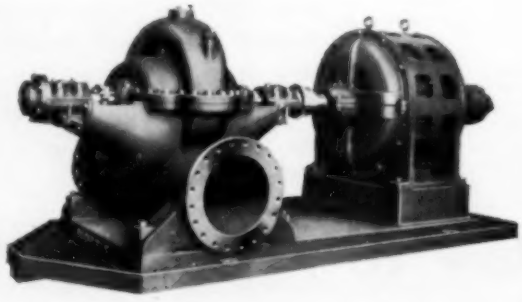

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For Drainage and General Service

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Mid-September, 1955

THE Coal Age

Mining Guidebook and Buying Directory Issue

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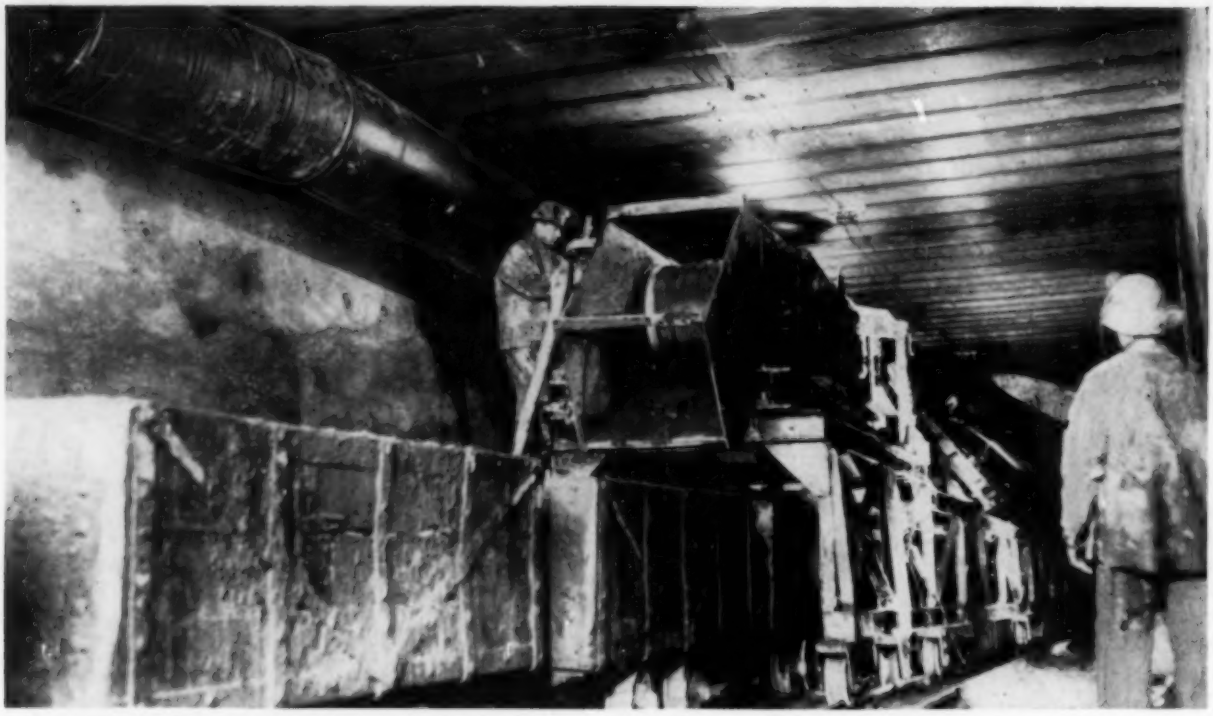


MACHINES SPEED DEVELOPMENT AND CUT COST. Here, a belt-type overhead loader receives muck from a three-drum slusher sinking a belt slope and distributes it to cars handled by a hoist on the surface.

Opening and Development

Portal Location

LOCATION OF THE MAIN OPENING and main plant for the lowest over-all cost requires study and balancing of many diverse factors. Normally, if a shaft or slope is required, and the coal is level or only slightly pitching, the shaft or slope is placed as nearly in the center as possible. This keeps haulage and travel distances to the minimum over the life of the property. Normally, also, other things being equal, the opening should be made to permit haulage on the level or downgrade for loads as far as possible if the dip of the coal is over, say, 1½ or 2%.

A slightly deeper shaft or slope, or a slightly longer coal haul, might be warranted to permit locating the plant and portal at a point where there is ample room, including space for parking and present or future coal storage, with a minimum of excavation, grading and foundations. Room for expansion is another factor to be considered in plant location. The fact that it usually is cheaper to haul coal on the surface than underground also might be a factor in locating a portal away from dead property center to get a more favorable layout. Even the availability of water for washing, and of space for sludge ponds and clarification equipment, provided washing is done or contemplated, could be determining factors if other things were approximately equal.

Sinking Rock Slopes

The following equipment normally will be required in sinking slopes in rock where the mining company prefers to do the work itself:

Shovel, dragline or bulldozer for preliminary excavation if the material is fairly deep and soft. A bulldozer normally is required in any event for miscellaneous earth moving and excavation, and for spreading refuse. These and certain other units frequently can be rented, rather than purchased.

Storage bin on surface unless muck is dumped directly to trucks. Normally, a bin will pay off by preventing delays and interruptions.

Refuse-disposal and service trucks.

Electrical substations or engine-generator plant.

Field shop.

Field supply house.

Field office, locker and change facilities. These, as well as the field shop and supply house, may all be in the same structure or separate buildings may be employed, including semi-portable or prefabricated. Though it is not usual practice, the permanent buildings may be erected in advance of portal development.

Fan or tubing blower, with duct or tubing.

Water supply for wet drilling, sprinkling and general use.

Pumping equipment, if necessary, for dewatering slope.

Concrete-mixing facilities, unless ready-mix is available at a desirable price. As an alternate to at least part of the concrete work, steel liner plate may be employed. Concreting or lining normally is done only for the softer section of material at the top of the slope. Below that, the natural-rock ribs normally will stand and the top can be taken care of by bolting or conventional timbering. Bolting also may be employed to keep ribs from sloughing or caving. Spraying with a sand-cement mixture on wire mesh also may be done to prevent spalling and disintegration as a result of temperature and moisture changes, or the ribs may be coated with roof-sealing compounds.

The usual belt slope also is employed for handling men and supplies. Consequently, the belt normally is placed to one side with the track at the other and the stairs in the center. However, all other arrangements have been employed, including increasing the height of the slope and putting the belt on crossbeams over the top of the supply track and stairs. The belt or supply track may be separated from the other facilities in the slope by guard rails, low concrete curbs or walls, or a center line of roof supports. For easy walking, one mine built experimental steps and had men try them. As a result, the stairs were built with a 6-in rise and a 24-in tread.

Because of the length of time required in sinking the longer slopes, and also because of the long tubing runs that would be required, it may become desirable to erect a center partition, thus establishing two compartments for ventilation. Rather than use shiplap or standard brattice lumber, thin-section plywood in standard-sized sheets offers economies in both purchase cost and cost of installation.

Methods of handling heavy inflows of water from soft water-bearing measures including standard grouting and also the use of gel-type chemicals which solidify after pressure injection and render the material impervious.

SINKING SYSTEMS

Depending upon the mucking system adopted, equipment normally employed in slope sinking is as follows:

HAND MUCKING

Hoist on surface (50 to 75 hp, single drum, in most instances; same hoist may be continued in service to handle supply cars in regular operation).

Muck car.

Air compressor.

Drilling equipment. In at least one

Where to Find It in . . .

The Deep-Mining Guidebook

"HELLDIVER" (left) facilitates loading in sinking coal slopes. The big drill (right) is one tool for speeding up the raising of parallel airways, drilling as many openings side by side as are required for the necessary air flow.

instance, a slope has been sunk using standard post-mounted electric coal augers—reportedly at a substantial saving. Normally, however, air is required in going through rock. Hand-held or other unmounted drills may be used, but their footage is lower. At the other extreme, a track-mounted jumbo—one or two drill mounts—may be employed for maximum drilling speed in slopes up to 45 to 50 deg. Between the two extremes are column- or bar-mounted drifters or sinkers, as well as the newer air-leg or jack-leg units.

Roof-bolting equipment rounds out the list, unless conventional supports are employed.

Minimum crew for such a sinking job probably would be approximately as follows, these men also taking care of installation of lining and roof support when not engaged in regular duties: drilling shift — two or three drillers, mechanic or electrician, and a handyman (hoisting, supplies, etc.); mucking shift—two or three muckers, hoistman, truck driver and dozer operator. It sometimes is possible for one man to take care of all hoisting and refuse disposal, although normally more than one are necessary, in which event the truck driver, dozer operator and any others employed normally will handle miscellaneous duties. And, as noted, all men will be available for installing lining, supports and the like. On this basis, average advance in a 7x15-ft slope would be 3 to 4 ft per shift—perhaps more with favorable conditions or jumbo or other high-speed drilling.

MACHINE MUCKING

Hoist.

Muck car or conveyor system. The latter may be chain equipment only, or a chain unit may be used between the belt unit, which eventually will become the slope conveyor, and the face.

Standard coal-loading machine, or rock loader of the standard, overshot or slusher types.

Air compressor.

Drilling Equipment — substantially the same as with hand mucking. However, where crawler loaders are used and consequently cannot be hoisted out readily it may be difficult to use jumbos because of interference.

Roof-bolting equipment (unless conventional support is employed).

Pitch usually dictates to a considerable extent the type of loader that may be employed. Standard or conventional loading machines usually are limited to 20 deg or less, though the overshot unit of the track-mounted type can operate on somewhat heavier inclines. With certain types of slushers, mucking can be done at up to 50 deg, other conditions being favorable.

The "helldiver," though employed mostly in coal (see following section on "Sinking Coal Slopes"), also may be adapted to sinking in rock at pitches up to 50 to 60 deg. Incidentally, where conveyors are employed to move muck the practical limits are about as follows: belt 17 to 20 deg; standard chain 30 to 35 deg; special high-flight chain conveyor designed for hoisting work, 45 to 50 deg. Where the slope is long, chains must be used in tandem, since the practical working length usually is not over 300 ft, particularly if operated up hill.

With slightly different duties, crews for machine mucking can be about the same in number as with hand mucking. Rate of sinking in a 7x15-ft slope, including lining and support, usually ranges from 6 to 12 ft per shift.

CONTINUOUS SINKING

Sinking machine. To date, these have been of the boring type and have been used only in sinking belt slopes on inclinations of around 20 deg or less.

Conveyor system (muck car an alternate).

Roof-bolting equipment (unless conventional support is employed).

The use of continuous-type mining-and-loading machines for slope sinking is a relatively new development. Results so far indicate that advances of 10 to 30 ft per shift are possible, depending upon the hardness of the rock. Since hard sandstone, limestone and the like still are tough for mining-and-loading machines, they normally should be considered only where shales and other soft material predominate.

Sinking Coal Slopes

Except that the product normally is not dumped to refuse, sinking slopes in coal is substantially similar in practice to sinking in rock. Equipment

DRILLING FIRST to outline shaft where the cover is shallow speeds sinking and protects walls against shooting, reducing need for lining.

BIG CORING-TYPE DRILL sinks small air and man shafts quickly and economically.

normally is of the coal type, and aside from loaders and the like, may include coal cutters unless pitch, interference or other conditions prevent their use. Except for certain anthracite applications and some exceptionsin bituminous mines, electric coal augers are standard for drilling, and the cycle corresponds with the cycle in a room face.

Cars or skips may be loaded by hand up to 75 to 80 deg. Conveyors may be loaded by hand up the limit of 45 to 50 deg for the special high-flight hoisting type. With loading machines, the usual limit for conveyors is around 20 deg. The maximum nose-down pitch for continuous miners still is to be determined, but they are promising candidates up to 15 to 20 deg.

The "helldiver" is one of the special machines for fast loading in slopes up to 50 deg. It consists of a scoop on the front end of a weighted truck (for construction details, see *Coal Age*, May, 1951, p. 100). With the scoop down, the helldiver is dropped into the loose coal at the face. In the hoisting phase of the cycle, the scoop is raised automatically and the entire unit is pulled to the dumping point—normally a hopper under the track with an opening between the rails. The hopper is above the haulage level and false rails permit hoisting over the level track. Coal is transferred from the hopper to cars on the level road by an elevating conveyor.

In 4½ ft coal, places 10 ft wide, with crews of 3 to 4 men, average production with the helldiver is one 7-ft-deep cut per shift, including installation of permanent roof supports and other necessary operations. With loading machines in slopes under 17 or 18 deg, 5-ft coal or thicker, the usual advance is 1 to 3 cuts per shift, with the higher figures possible as a rule only where there is little need for installing permanent supports. Advance with hand loading, whether into cars or conveyors, seldom is over one cut per shift with a 3- or 4-man crew.

Raising Slopes And Airways

As in sinking, raising of slopes and airways under, say, 20 deg in either coal or rock can be done with machine mucking or loading, or with hand loading. Although equipment can be installed to take cars to the face, the preferable transportation medium is the conveyor up the point where the material will run on sheet iron, which is around 30 deg. At around 35 to 40 deg, coal will begin to run on the bottom rock, and above approximately 45 deg, checks or batteries are required.

Where raising is done in coal, continuous miners have been successfully used in pitches up to 15 deg or better. In one instance, using pickup loaders, shuttle cars and cross-measure shakers for gathering, six airways were driven 1,500 ft up pitch to the outcrop by ripper-type continuous units with a substantial saving in cost over other methods. Maximum pitch encountered was 12½ deg.

In addition to raising parallel airways with conventional equipment operated from crosscuts off the main slope, big drills also have been used. At one mine (*Coal Age*, May, 1951, p 100) such a drilling unit is fitted with a 42-in head, and one, two or three holes are drilled up the pitch to achieve the desired airway area. Drilling is done from crosscuts at the necessary intervals.

Shaft Sinking

Type of shaft determines to some extent the method of sinking. Unless shafts are required rather frequently better results usually can be achieved by contracting their sinking, especially if they are large and deep, rather than by purchasing equipment and creating a staff of specialists. Surface facilities and sinking equipment, except for mucking, are substantially the same as in slope sinking (see p 4-6). Lining materials, where required, include sprayed sand-cement and corrugated liner plates for circular openings.

Muck may be loaded into a standard sinking bucket by hand, though in a multicompartment shaft where a heavy cage can be used in one compartment, new positive-action mucking machines mounted on the cage bottom may be employed in loading the buckets. (see May, 1955, *Engineering and Mining Journal*, p 82, for example). Where the depth is not too

DOUBLE ARM TRACKMOUNTED JUMBO paves the way for machine loading to reduce cost and permit anthracite development by rock gangways.

LOWER COST, higher recovery and quick maximum production are among advantages of exploiting outcrop along with underground development. Shovel and bulldozer develop bench and auger mining in this example.

great, mucking may be done by a standard crawler-mounted clamshell operating from the surface. And if access to the bottom of the shaft is possible through openings that already exist or can be driven, the muck can be dropped through a pilot drill hole into mine cars below.

A new technique in sinking relatively shallow shafts—under 150 to 200 ft—and which may also find application in even deeper openings, is outlining the shaft by 6-in drill holes on centers of 18 in, using either a strip-type overburden drill or a standard borehole machine (*Coal Age*, April, 1955, p 74). Then the same drill puts down inner holes as required for shooting. Mucking is done by a crawler-mounted clamshell. In addition to a high rate of sinking (9½ ft per 7¼-hr shift with one 16-ft-diameter shaft), the walls are protected from shock, need not be scaled in sinking, and stand well without lining after the shaft is completed. Mucking is done without men in the shaft, except for cleanup.

Drilling is finding increasing application as a means of sinking shafts for air and emergency purposes, as well as for men and materials. These drills operate on the coring principle, with the latest employing dry oil-well-type cutters on the drilling edges. The entire drilling unit is lowered into the hole, along with the operator, and is hoisted to permit removing core sections. Its initial assignment (*Coal Age*, January, 1955, p 80) was drilling a 75-in hole 467 ft for a man-shaft. The hoisting equipment for this shaft, incidentally, is of the so-called friction type without a rope drum or drums.

Rock Tunneling

In starting a rock tunnel from the outside, it may be possible, as in slope sinking, to use a dragline or some other type of excavator to go through the soft material. At some mines, this initial cut has been left open, with the sides stabilized by planting special ground covers. At others, a concrete section has been installed, as in slopes, and covered with excavated material. Cut-and-cover has the advantage that the material need not be hauled away, compensating in part for the cost of the lining.

Even though not designed for such duty, coal equipment often is pressed into service where rock tunneling is a special job occurring only once in a great while. The coal equipment, of course, includes loading machines and shuttle cars and conveyors. Where rock tunneling is required most of the time, however, special rock facilities normally are employed. Rock machines includes loaders similar to coal machines but designed for rock loading; also overshot-type loaders and slushers or scrapers of the 2- or 3-drum type, the latter providing a greater degree of flexibility in covering the entire face. The machines may load into rail cars, regular or rock-type shuttle cars or conveyors.

Drilling normally requires pneumatic equipment and compressors. Drills vary from hand-held through air-leg, post-mounted and bar-mounted types to mobile single-arm and double-arm jumbos. Where considerable tunneling is done and other conditions do not militate against them, the mounted jumbo normally provides the greatest capacity and the lowest cost in drilling.

In one 8 x 12-ft tunnel using a duckbill for loading, a crew for one shift was made up of a boss, three heading men and one loading-end man. Average performance was two rounds 6 ft deep every three shifts. Drilling time (two drifters on a bar) averaged 3½ hr per round, and loading time, 6½ hr, including temporary timbering, advancing conveyor, etc.

In one 14 x 8-ft tunnel driven with

a regular rock-loading machine, average performance was two 10-ft cuts per day of four 6-hr shifts. A four-man drilling and charging crew using two post-mounted drifters normally drilled and charged 26 holes in less than a shift. The cut then was completely mucked on the next shift by a 3-man crew. A ditch 5 ft at the top, 3 ft at the bottom and 3 ft deep was mucked by a hoe-type scraper working behind the rock loader.

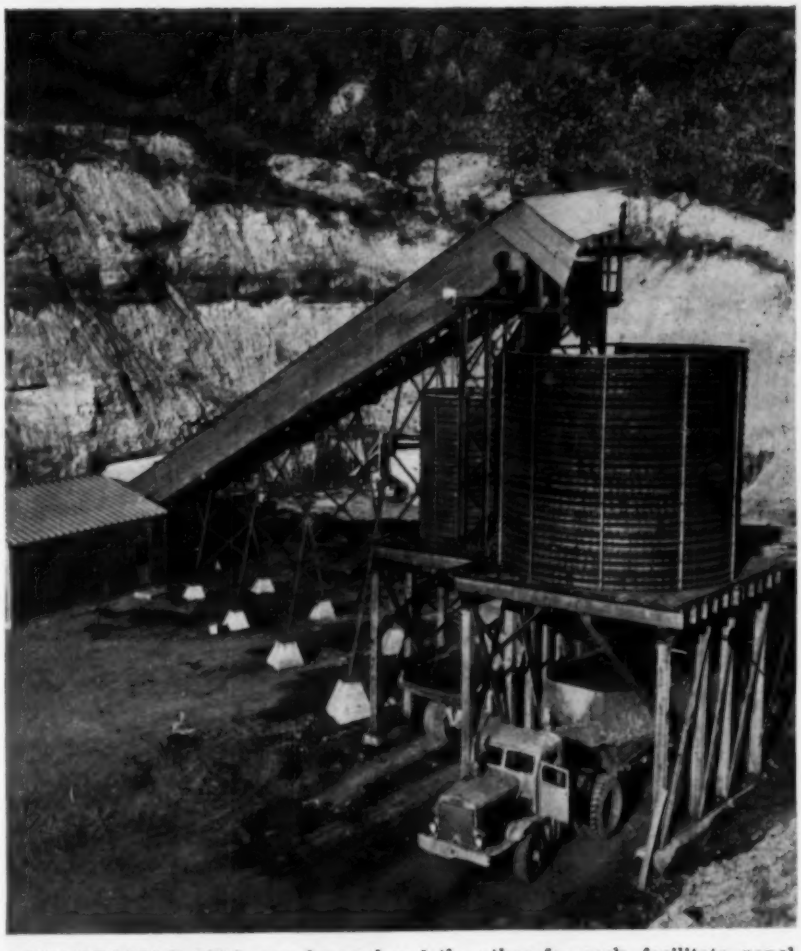
In an 8 x 12-ft tunnel with 2 x 1-ft ditch on one side, drilling was done by a trackmounted double-arm jumbo and a car transfer was installed to facilitate switching cars behind the rock loader. The jumbo crew consisted of four men and the loading crew of 3 men. Average advance was 1 ft per hour. At this operation two or more places permitted shifting the machines back and forth.

Mine Projection

Full-retreat mining, mean mining from the boundary back to the bottom or portal, is the ideal system, with exceptions so few as to be negligible. Before the advent of the mining-and-loading machine, or continuous miner, however, the rate of entry advance was relatively slow, even with the best of machines and systems. Therefore, complete adherence to the principle meant a rather lengthy development period during which coal production was relatively small. As a result, a number of compromises were employed.

One compromise providing results frequently as good as full retreat is advance on one side of the mine or working territory and retreat on the other to complete extraction. The basic principle is followed completely if full retreat is practiced in the individual working sections, though here again rooms may be mined on one side of a production entry on the advance, and on the other side on the retreat.

Other methods of providing coal while entries are being driven for a full or approximately full retreat system include setting off a special territory well protected by barriers near the bottom or portal, which can be mined, caved and abandoned without risk of affecting the permanent facilities. And where the coal outcrops along a hillside, quick production can be attained by moving in a shovel and stripping the outcrop, not only recovering coal in the stripping operation but also opening up the vein for augering or for deeper recovery by standard underground equipment, such as, a panel belt with loaders, shuttle cars and auxiliaries. If heavy rock or some other handicap makes true stripping undersirable, but conditions are such that benching is feasible and economical, augering or paneling still may be not only a help in development but also a source of considerable low-cost tonnage.



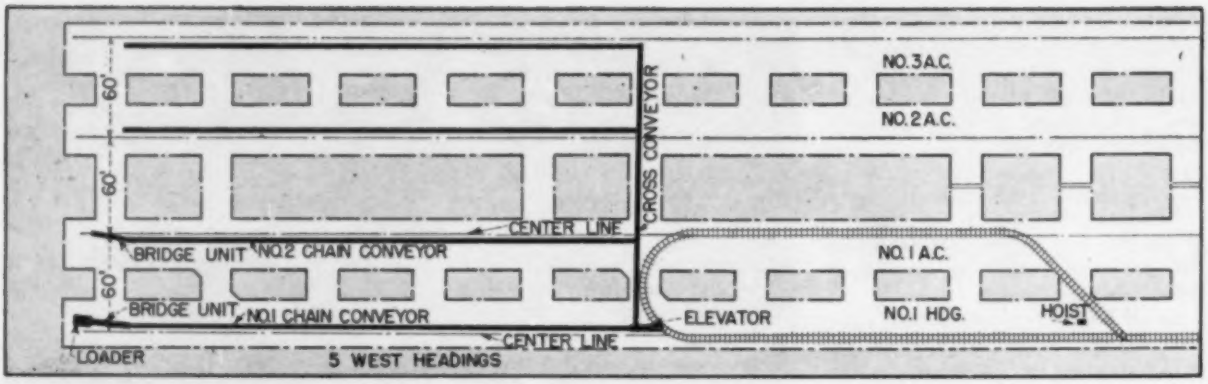
SEMIPORTABLE BINS, one for coal and the other for rock, facilitate panel mining from outcrop. Trucks move coal to preparation plant, and coal bin has sufficient capacity to hold second-shift output.

With the development of the mining-and-loading machine, the problem of going to full or near-full retreat in the thicker seams—and eventually in the thinner—is materially simplified. This results from the fact that the machine's rate of production is the same or almost the same as when working in rooms. Therefore, if the plan is to use four machines two shifts, they can all be concentrated in driving headings, providing full or nearly full production from the time of breaking away from the bottom or portal.

CONTOUR DEVELOPMENT

In mining hilltops and knobs, the panel belt and other modern equipment permits economical recovery at a high rate of production, whereas such areas frequently were impossible to operate when everything had to be done underground. Now, the outcrop is opened by a bulldozer or shovel—the latter normally is required to make the necessary width of bench—and the coal is mined by all-conveyor units of the hand-loaded or self-loading types, or by loading machines and shuttle cars feeding to mother conveyors or panel belts. The belts in turn may feed to mine cars on track laid on the bench. As an alternative, especially where it is desired to work sections large enough to warrant a mainline belt, the coal may be discharged to a semiportable storage bin for trucking to the main plant. By erecting the bins in multiple, it is possible to store the full output of a second shift, for example, eliminating the need for trucks and preparation facilities on that shift.

In addition to conventional equipment, contour development and pro-



BRIDGE CONVEYOR-LOADER SETUP with loop track for cars is one of the entry-driving systems providing maximum advance with minimum cost. Cross conveyor brings coal from all four places to car-loading elevator.

duction may become one of the special provinces of the remotely controlled mining-and-loading machine. Remotely controlled boring-type equipment has been or is operating at distances up to 1,000 ft from the outcrop with both articulated conveyors and the extensible belt.

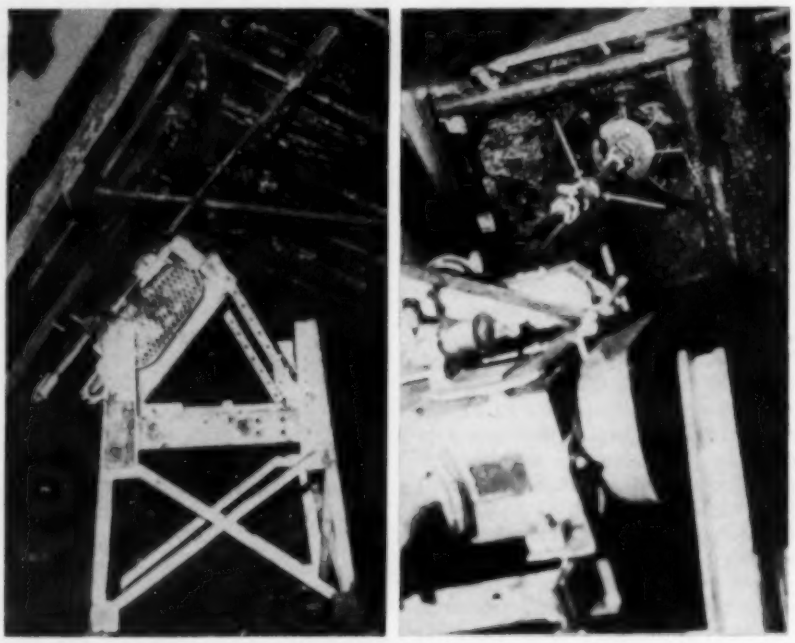
SECTION SETUPS

One question in setting up a mining section is whether to aim for complete isolation: in other words, a panel completely enclosed by pillars with no openings except for the panel headings. Considerations favoring complete closing of panels include: liability of the coal to spontaneous combustion, and the possibility of breaks in the roof to water-bearing strata. Closed panels facilitate sealing and damming where fires or water breaks occur. The closed panel also facilitates sealing to comply with legislation or the rulings of inspection departments.

Pillaring within a closed panel, however, is more difficult unless conditions are more favorable than those usually encountered. Therefore pillars frequently are left in place where panels are closed, though a number of operations recover them quite successfully.

Among the benefits of the panel system, whether completely closed or open, is ease in establishing splits for each individual working section. The panel system also lends itself somewhat better to the establishment of bleeder headings—a growing practice where gas emission is heavy and even where not for a general improvement in conditions. A major advantage is the fact that the working places are always in fresh air since the travel is one way over the active workings and gob areas to bleeder openings. An added benefit of such openings is the fact that they provide additional escape routes in case of disaster.

Bleeder openings may be established in a number of ways, some of which are illustrated elsewhere in this Deep-Mining Guidebook (pp 17, 20, 51). They may be openings from the face of the first or last room to the return of the entry from which the panel was developed or to the return of the preceding cross entry. Or, the entry may be extended to a special entry driven to serve as a bleeder and escapeway. Where pillars are mined the bleeder opening is easily formed by leaving the pillars in at the side or top of the section to preserve an air and escape route, which comes into service when the first room in the next adjacent panel is cut through. The pillars left for the bleeder openings in the first panel naturally are mined from the rooms cut through from the second, and so on for the succeeding panels or sections.



BORED CROSSCUTS in pitches cost less and require simple, inexpensive stoppings. New lightweight boring unit is designed with hoist in upper opening to pull big bits through pilot hole.

PILLARING PRACTICE

A second question in setting up a mining plan is whether to take pillars or leave them. Where the coal is thin, adding to the difficulty of mining, and the top is good enough so that pillar size may be cut down to a minimum, the tendency is to leave pillars. In contrast, pillars also are left in some thick-coal areas because of bad top. Basically, however, taking pillars, unless some special conditions prevent, is desirable to get full return on the necessary expenditures for entry-driving and other development operations. Leaving a third of the coal,

for example, means driving, supporting, equipping and maintaining a third more room entries for a given tonnage.

A subsidiary question is pillar size and shape. As a general rule, these are set by experience with the top, bottom and other natural conditions in the region, with another factor whether or not recovery is immediate. Aside from the weight question, square blocks and a standard width of opening everywhere result in uniform pillaring conditions all the time, thus tending to raise efficiency. Angle driving, yielding "diamond" pillars, substitutes, as a rule, 60-deg turns for 90. Both mine cars and shuttle cars are favored by these gentler turns, but ease of operation in other directions may dictate retention of the 90-deg principle.

Changes in equipment type also influence practice in sizing pillars. Thin pillars between rooms, for example, facilitate crosscutting and pillar extraction with bridge conveyors. Otherwise, after the reach of the bridge unit is exhausted, an auxiliary cross conveyor and drive would be necessary. Even without special equipment, then pillars may be desirable for several reasons. As an example, to get maximum extraction in first mining, one operator reduces pillars to two-cut thickness. The final recovery step is slabbing one cut off the pillar and leaving the remainder.

Entry Driving

Number of openings becomes possibly the first question in developing an entry-driving program. In moderate to steeply pitching coal, the difficulties of developing under such conditions normally limit the number to two—a gangway for haulage and an airway above. At a fair number of collieries, gangways in coal have been given up for rock tunnels underneath the vein, though the airway still is made in the coal as a rule, with connections for ventilation and mining through rock chutes. In lighter-pitch coal, conditions are more favorable to increasing the number of openings, though the general practice still is to keep the number as close to two as possible.

Among the factors involved in establishing the number of headings for an entry in flat-coal mining is airway area. In the thinner seams, especially if the air volume is expected to be large, driving additional openings to keep down velocity yields substantial savings throughout the life of the mine. But even after all the necessary openings for haulage, ventilation and man travel have been provided, it still may be desirable to increase the number. This is especially true with loading machines, and to a lesser extent with certain other equipment. The goal in increasing the number of headings is to make development work as near like room work as possible, which means the lowest cost, aside from a higher tonnage from the equipment involved. And since development and room work are so nearly alike, management is relieved of a large part of the complications involved in scheduling development to provide production territories.

The continuous miner and the bridge conveyor, among other new devices, are however, reducing the need for increasing number of headings for the sake of lowest face cost. A loader in two places equipped with bridge conveyors, for example, often can achieve higher tons per machine and per man, and thus a lower cost, than the same machine with conventional transportation in a considerably large number of places. This is particularly true in the thinner seams. Therefore, if only four headings were required for mine development, keeping to that number would not curtail unit output or militate against low cost.

With continuous miners, the case is even more pointed. Such a machine, in effect, doesn't care whether the opening is a heading or a room. Therefore, it is not oversimplifying things to say that the production and the cost are the same. Consequently, there is no need to increase number of headings to enable the machine to do a better job.

Equipment for entry driving in coal normally is the same in type and general method of use as in other coal work. With mine cars or shuttle cars, any convenient layout for track or transfer stations may be employed.

With conveyors, whether loaded by hand or machine, some form of cross unit normally is necessary to bring the coal to one point, for transfer either to a mother belt or mine cars. One layout, based on bridge conveyors (*Coal Age*, September, 1954, p 106), is shown in the accompanying diagram. The cross conveyor brings all the coal to an elevator. Cars are loaded in trips on a loop track, with movement by a hoist. Instead of the loop track, tail tracks for pushing in and pulling out are common in receiving coal for both conveyors and shuttle cars. Frequently, to get the necessary length of tail section, it is turned into a room or through a crosscut, with the elevator on the curve. Loading sections sometimes are paralleled by passing tracks either in the same or parallel headings for greater convenience and less loss of time in changing trips. Trip control systems and equipment are discussed in more detail in the section on "Transportation" (p 38).

Crosscutting on Pitches—The making of crosscuts between gangways and airways is one of the most costly and aggravating operations in developing for pitch mining. The big drill —36 or 42 in, or larger—has been suggested and used for this purpose (*Coal Age*, May, 1951, p 100). A new unit (*Coal Age*, August, 1955, p 58) is designed for pulling the big bit by a wire rope through a pilot hole, thus decreasing drill size and also weight to a few hundred pounds. One advantage of drilled crosscuts is the fact that they are small, though still large enough to carry the required volume of air. Consequently, they can be closed with a simple wood or steel disk, rather than an expensive custom-made stopping.

ROCK HANDLING

Where taking rock is a matter of brushing top or lifting bottom in a haulage road, as distinguished from regular tunneling, the tendency is to use coal equipment to save the cost and complications involved in employing special equipment. General practice is to alternate with coal and rock cuts, whether in the top or the bottom. Other operators, however, drive in coal various distances, usually from one crosscut to the next, or some other fixed distance—100 or 150 ft for example—before taking top or lifting bottom. This is facilitated by the use of rubber-tired haulage units.

A balancing of all the factors may result in a decision to haul all the rock made in attaining height to the outside for disposal. However, disposal in the mine avoids the haul outside and the supplementary operation of throwing it away on the surface. Some of the methods adopted for underground disposal are: (1) stowing along the rib where the opening can be made wide enough for this purpose; (2) stowing in crosscuts; (3) stowing in openings made especially for the purpose—for example stubs driven into barrier pillars; (4) stowing in special gobbing rooms or back entries. At one anthracite operation in light-pitch coal, as an example of the latter, a lower "water gangway" receives rock from a cross conveyor laid through the crosscuts (*Coal Age*, July, 1955, p 74). In flat coal, the fact that the shuttle car is not limited to one opening or route makes it especially useful in stowing in crosscuts or special stubs, rooms or entries.

The Deep-Mining Guidebook . . .

Mining and Loading

Equipment Selection

WITH THE VARIETY of equipment available today, it is only under exceptional conditions that the choice is limited and only one or two possible types can be installed. One exception for the moment—is flat or mildly pitching seams under 30 in. Even here, there is still some choice of self-loading equipment, including the scraper and the duckbill or sawbill. Machines of the mining-and-loading type include the coal planer. Hand-loaded equipment includes the hoist-operated scraper-type hauler and the various forms of room conveyors—chain and shaker principally. The auger, so far used for special purposes, such as, preventing bumps, should be a contender in thin-seam mining in the future.

The equipment noted in the preceding paragraph also may be used in the thicker coal, and is fairly common up to 4 ft, but the development of on— and off-track loading units, which offer the advantages of flexibility and high capacity, along with ease of moving, has resulted in their taking over to a considerable extent in coal thicker than 3 to 3½ ft. Off-track haulage equipment normally accompanies off-track mining equipment, though it is being challenged by the extensible belt, the bridge conveyor and other new conveying developments providing very close to continuous haulage. Such units also can cope with very soft bottom which, in the past, has resulted in a few instances of adoption of track haulage even when rubber-tired haulage units were available.

With the exception of the planer, the auger, the stripper and the short-wall-type miner with double auger head, the trend in mining-and-loading machines, or "continuous miners," is, as with conventional loading equipment, toward mobile units. So far, there has been little use of miners of the mobile type in coal under 4 ft, though machines for mining down to 3 ft may be expected in the future. Under 3 ft, the mobile miner of tomorrow, as some see it, probably will be a remotely controlled or operated unit capable of mining across considerable distances between pairs of service openings.

Remotely controlled machines, as noted, include the auger, which has been used to a limited extent underground. This use is expected to increase. Other than the auger, remote machines so far placed in service have been controlled and operated from the surface. Operating them from underground stations involves an engineering and design problem of some magnitude, though not an insurmountable one. One big advantage of remote mining is the fact that exposure to roof hazards is sharply reduced. A second is that production places need not be timbered or bolted. On the other hand, control equipment, special cable reels and cable, and the like are additional or more-expensive items. However, results from initial remote-mining operations are such that their continued growth in the future is assured.

PITCH EQUIPMENT

Conventional conveyor and mobile equipment can be used with a high degree of efficiency up to approximately 18 to 20 deg. At 10 deg or less there is only a slight difference in results, if any. Where haulage is concerned, the breaking point where conveyors usually must be substituted for rail cars or shuttle cars usually is around 5 deg. However, rubber-tired equipment has been used in crosspitch rooms or chambers to around 12 deg. The maximum pitch on which mobile machines may be empioyed is yet to be determined. However, a Canadian-developed ripper-type miner for longwall work has successfully operated for considerable periods of time down a pitch of 30%.

Explosives and gravity remain the major production tools where greater than sheet iron pitches are encountered. To make it possible to bring these forces into play with a minimum of labor, major emphasis is being placed on the development of the longhole drill.

Using Equipment Efficiently

Whatever the system of mining (see later sections in this Deep-Mining Guidebook for analysis of various types) the overriding goal should be keeping the face units producing at capacities as close to 100% of available working time as possible. To achieve this goal, coal should be available all the time, the machine should be in shape to work without stoppages, and means of getting the coal away should be continuously available. The job involves all echelons of operating management down to the section boss, as well as engineers and other staff men. With this as the key, the job of running a section—or a mine—takes in the following:

1. Establishing Production Standards. Assuming a machine has a rated capacity of 8 tpm and available working time is 400 min, it should produce 3,200 tons per shift. Actually it doesn't—and for good reasons. But what should it produce: 500 tons? 800? 1,000? There is a proper figure, which can be arrived at by the application of industrial-engineering principles. This means studying the operation piece by piece with a watch and a record sheet to determine not only where delays and efficiency occur, but also how much time normally should be required to perform each operation, such as "Tram to next place." When finally compiled, this information makes possible the setting of a pro-

duction standard which represents a fair day's work for a fair day's pay. Normally, by making manpower more effective through better distribution of work and a better balance in the production cycle, this means a higher output than otherwise would have been attained. Savings of up to 30% in total mine cost have been reported through establishment of production standards in this fashion.

2. Synchronized Operation. Some of the benefits of balance in the cycle have been noted in the preceding paragraph. Balance also must exist in equipment capacities if over-all balance is to be secured. A cutter or a drill, for example, which is unable to keep up with the loader reduces over-all unit output while the wage bill remains the same, thus running up the cost. The synchronization phase of balanced operation becomes particularly important in conveyor places. Detailed study of the operation permits meshing of cutting, drilling, shooting, conveyor and timber advance, and other operations so that loading is interrupted for only the bare minimum of time.

3. Performance Records. The need for records will vary with the responsibilities of the supervisor, manager or staff man, but whatever the degree of responsibility, daily, weekly and monthly records should be detailed enough so that the man can compare present with past performance in his own section and department, and also with other sections and departments. Delay records are almost as important as production records, since they provide the basis on which concrete steps can be taken to avoid a recurrence.

4. Trained Men. This does not mean only formal courses or schooling, though those that have installed such courses report that they are well worth their cost. But even without formal indoctrination, the alert supervisor can fairly well determine practices that contribute to low cost and safety and those that do not. Following that, he is in a position to pass this information along and work for its acceptance. Real down-to-earth training results, for example, when the cost of reconditioning a bent cutter bar is presented to an operator along with some suggestions on how to prevent a repetition. Training, too, takes place when a supervisor and a loader operator work out a scheme for attacking a fresh cut and loading it out with a minimum of moves and position changes thus shortening over-all loading time.

5. Rated Voltage. Not only does voltage less than the nameplate rating slow down equipment, particularly DC—it also breeds a don't-care attitude among crew members and burns out armatures, coils and so on, increasing maintenance cost and upping section cost. Good voltage at the working face should be a primary concern of all operating, electrical and maintenance officials.

6. Expert Machine Care. Low cost today depends on keeping machines running as much of the time as possible at rated capacity. Stoppages resulting from machine breakdown cost as much as idle time from any other cause. Skilled preventive attention is the answer, meaning that a good repairman should never be too far away even if not actually stationed in the section. His main job, however, is inspection and checking to catch trouble before it starts or make repairs while they take only a few minutes rather than the lengthy periods required for major breakdowns. It helps, too, when foremen and operators have some degree of familiarity with machine design and preventive maintenance methods, including good lubrication.

7. Supplies when Needed. Small breakdowns can have severe consequences when it is necessary to send outside or to some other distant point for a part that should have been in the section stores. The moral is to make sure that the supply items of the right type are at the right place at the time they are needed. This includes even mine props, roof bolts, rail, ties and anything else the lack of which might slow down or stop production.

8. Transportation When Needed. "Continuous" transportation is provided by conveyors, but depending upon the type of production and haulage facilities, shuttle cars and rail cars can provide the equivalent of continuity under most circumstances. Lack of continuity shows up mostly in serving continuous miners, which has led to the development and wider use of conveyors behind such machines. The need for "continuity" also applies to mainline haulage, which should be set up to have an empty trip at each transfer or loading station before the previous trip is loaded out. Also, transfer of coal to cars should take place without delaying the shuttle car or conveyor, meaning that facilities should be provided for shifting cars while the coal flow continues, unless, for example, shuttle-car and mine-car capacities are identical.

9. Competitive Spirit. Pride in achievement is a powerful stimulus to excellence in results, whether in production or in baseball. A "beer bust" is one form of reward for a record-breaking job, but incentives do not have to be tangible to achieve results. Merely pointing out the crew standing, with praise if at the top or with pointed reminder if down the list, usually can stimulate the competitive spirit to a substantial degree, with consequent salutary effect on production and cost.

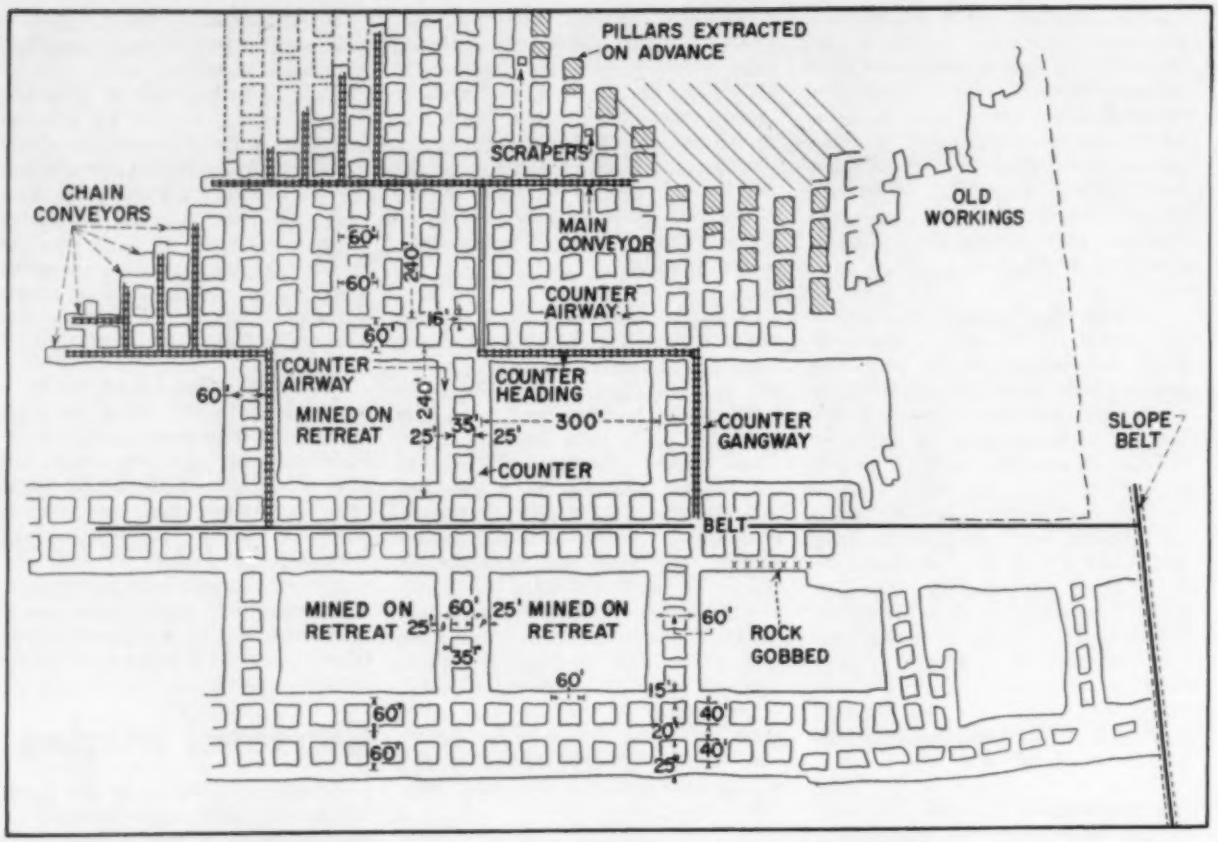
10. Safety Always. Last but by no means least in any set of principles for running a mine or a section is constant emphasis on safety. Aside from everything else, injuries cost in increased compensation and medical payments, in lost output, and very frequently in damage to mine and equipment. Even where no injury results, a roof fall, for example, can tie up machines and involve anywhere from a minor to a major removal and cleanup expense.

Conveyor Mining

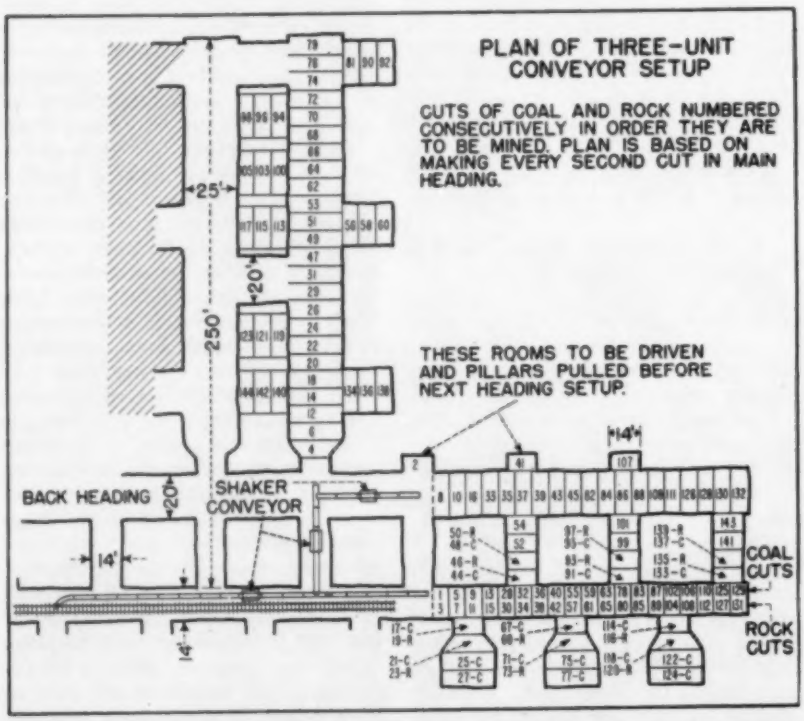
Although the variations are almost infinite, conveyors today normally are used in groups of two to four. Benefits are those usual with concentration. Single conveyors are found mostly in pitching coal, and in second or third mining of anthracite. And whether single or multiple, in rooms or in entries, conveyors usually discharge either to a panel belt or to a gathering or cross conveyor concentrating the output at a single car-loading point.

Chain conveyors—belt units seldom are used in room work or heading advancement—require a drive for any change in direction. It is possible to bend standard chain units slightly, though it is not recommended because of increased wear. Thus, when hand loading onto chain units, it is necessary to keep place width down to practical shoveling distance unless face conveyors are used.With face units, rooms can be driven 50 ft, 60 ft or more in width where roof and other conditions are favorable. Wider faces ease the problem of arranging the cycle so that loading proceeds with minimum interference and maximum efficiency. And even though the face conveyor is longer, putting it on wheels or rollers and designing the joints for for quick breaking and making (*Coal Age*, October, 1952, p 77, for an example) permits rapid moving even where close timbering is necessary.

With shaker conveyors, swivels make it possible to swing the face end



CASCADE DEVELOPMENT up the pitch with two groups of conveyors plus scrapers for recovering pillars. Chutes and lowering conveyors bring the coal down to the main belt in the crosspitch gangway.



HEADING ADVANCE alternates with room work in this conveyor plan, based on mining one side on the advance and on the other in final retreat. Rock is loaded every second cut in haulage heading, where necks are made extra deep.

rather readily, provided jacks and posts do not interfere. Thus, within limits it is possible to widen the place without going to face units or turning the trough. At the same time it is possible to keep the face end of the conveyor in the most favorable position for hand loading. Ability to use swivels and turns permits driving crosscuts and working pillar places without separate drives. Bellcranks also permit operating separate trough lines from the main unit as desired. Uphill types with curved discharge chutes also can lift coal or rock and load it into cars without auxiliaries.

Adding a duckbill or sawbill makes the shaker conveyor self-loading. Power swing and power advance and retract also are available on duckbills. Compared to loading by hand, adding a duckbill, sawbill or power duckbill increases the number of cuts that can be mined in a shift by from one to three, thus, in some instances, as much as doubling the output per shift.

CONVEYOR PLANS

The plans adopted for conveyor mining are as numerous as the variations in equipment units, but the most-used ones are two:

1. Driving the room entry up the full distance and then working rooms on one or both sides on the retreat. If mining is done on both sides of the panel, one equipment unit may alternate, or matching units may be used on both sides. Where the coal pitches and entries or gangways are driven on the strike, places naturally are turned up the pitch. Occasionally, as shown in the accompanying plan, a sub-opening may be established up the pitch to permit two or more groups to be operated in cascade fashion. A variation is driving stubs up the pitch, equipping them with proper lowering equipment, then turning rooms across the pitch starting at the top of the stub and working down.

2. Developing the room entry and at the same time working rooms on one side on the advance, then completing the panel by retreat on the opposite side, is another common conveyor system. This normally results in a more even output rate over the life of the section, and also keeps all working sections on the fresh-air side of the panel ventilating system. In driving and advancing on one side, the entry, as shown in the accompanying plan, may be advanced a certain distance and then the equipment moved into the rooms to mine them out, after which another entry advance is made.

In any system, most operators like to prepare room necks in advance. Thus, if the entry is completely developed in advance, places may be necked 2 to 3 cuts on one or both sides to be ready for final mining—that is, with a two-heading entry. However, if chain-pillar crosscuts are made on room centers necking may be unnecessary on one side. And with a three-heading entry, with the belt in the center, crosscutting on room centers can eliminate any necking on either side, though many operators still feel that it is worth driving in to the point where room widening starts. Also crosscutting on such short centers may be undesirable from several standpoints, including extra stoppings and more likelihood of roof trouble.

Pillar Extraction—Where the coal is under 3 or 3½ ft and the top permits, many operators prefer to reduce pillars to a minimum and leave them, some arguing that the value of the coal left is less than the cost of the timber that would have to be put in to recover it. In at least one instance part of the pillar is pocketed out and the remainder left to protect the next pocket, eventually crushing with subsidence of the top. Where pillars are taken, usual practice is to widen to one side only, putting the conveyor along the straight rib where it is close to the pillars to be removed. In mining individual pillars, any one of the conventional methods—slabbing, pocket-and-stump, open-end, and so on—may be used, depending upon conditions and managerial preference.

UNIT ORGANIZATION

Aside from the room and—possibly—face and cross conveyors and elevators, the usual practice in setting up a conveyor unit is to put a shortwall cutter and a drill in each place. Attempts to move cutters from place to place make it difficult to set up a tight face cycle, which is essential for maximum efficiency. Drills may be separate, each with its own cable, though a common practice is to plug drills into cutting-machine takeoffs. Flexible-shaft drills, likewise operating from cutter takeoffs, have made major strides in conveyor and other mining in recent years, as has the hydraulic hand-held drill powered either from the hydraulic system on the cutter or, if the cutter has no hydraulic facilities, from a special portable pumping unit.

Other equipment frequently found in a conveyor setup includes specially designed rockdusters and bolting units. Supply-handling equipment includes wheeled dollies operating in pan lines, and small hand or powered winches to pull timber and other heavy materials up to the face in pitching coal. The false pan line is a simple and effective alternative in flat or mildly pitching coal. Until the halfway point of the place is reached, a false line is built alongside the regular line by pulling it forward and attaching a section each time the regular conveyor is extended. Each new false pan is loaded with enough supplies to take care of that much advance of the face, and when pulled up by the cutter and unloaded is added to the regular line. When the last section of the false line is pulled up, the room is completed.

Outby the rooms, supplies may be brought in by rail trucks, by rubber-tired equipment or by reversing the panel belt. Some belts have been fitted with jogging and inching controls for this purpose (*Coal Age*, April 1946, p 86). In moving drives from one group of rooms to another, power usually is provided by the cutting-machine rope. Shortwall trucks make handy carriers, however, and are widely used. Special carriers, some equipped with winches, also may be acquired for moving drives, pans and other heavy units. Light three-wheeled trucks and even toy wagons are good devices for moving smaller items.

SCHEDULING FACE WORK

The usual face crew, whether loading by hand or power, is 3 or 4 men, with as high as 10 to 12 on extra-long faces. Average output, hand loading, is 1 to 3 cuts in the usual rooms. With self-loading equipment, production is increased to 2 to 4 cuts per shift—sometimes more.

Attaining production rates of this magnitude requires a careful study of crew size and operating cycle. Unless places are extra-wide or some special situation exists, the usual face crew, as noted, is 3 to 4 men. More than that number under normal conditions seems to result in interference and lost time.

The cycle itself is the critical factor in high productivity. For high efficiency, the various elements in the cycle—cutting, drilling, shooting, etc.—must overlap, and must be tightly scheduled to prevent waste motion and time loss. The basic goal is as little interruption in the flow of coal as possible. The best way of attaining it is through time study and the establishment of a fairly rigid system of standard times, plus a fairly exact schedule of when to do what each cut. If successful, all the men know what to do and when to do it, and their activities in the cycle mesh at every stage in preparing for and mining a cut of coal.

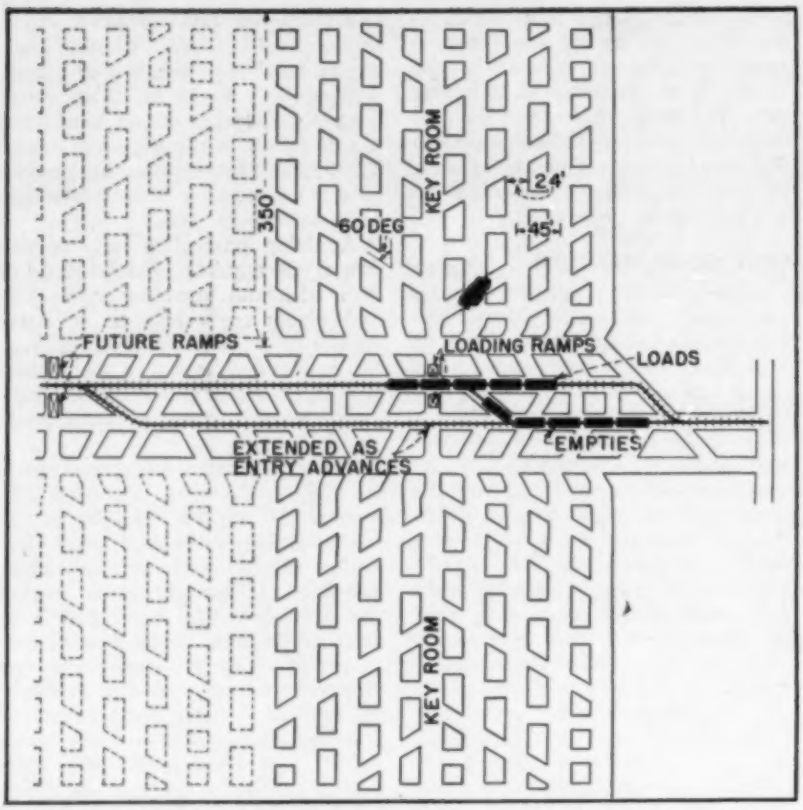
Machine Mining

The basic machine-mining unit, meaning here the unit based on a mobile loading machine, is made up of the loader itself, a cutter, a drill and, in most instances, one or two shuttle cars. Additional equipment may include a roof-bolting unit, a rock-dusting machine and a mobile supply truck.

A high degree of flexibility characterizes this unit, and thus it has been applied in practically all types of mining, including semilongwall, in both thick and thin coal and in both flat and lightly pitching seams. Number of working places per unit ranges from a low of two up to 20 or more. The average is 6 to 10. Crews range from 3 to 5 up to 20 to 25 men, with the most common around 8 to 12. Production per unit runs from as low as 100 tons up to as high as 1,500 tons per shift, with 300 to 600 tons as the majority. Tons per faceman ranges from 20 to nearly 100 in a few instances, with 30 to 50 perhaps the most common.

MACHINE PROJECTIONS

Because of the flexibility of the loading unit previously noted, mining



SHUTTLE-CAR PLAN showing double-tracking for mine-car loading, key rooms to loading ramps and angle crosscuts for faster shuttle-car travel.

plans range from completely closed panels with no pillar extraction to what might be termed the wide-open system with all openings—entries, rooms and crosscuts—projected on the same centers. This latter, if followed completely, results in dividing the coal into blocks of uniform size, permitting both flexibility in attack and at the same time, a standardization of extraction methods conducive to both high unit productivity and high tons per man.

Where pillars are removed with machine units, the tendency is to reduce the angle of the pillar line from 45 deg—sometimes down to zero, or to a completely flat line. Two major advantages result. One is that the span supported on the projecting points or stumps is materially reduced in going from 45 to some smaller angle. On a flat line the span vanishes. And as the span is reduced, the weight of top in the angle requiring support is reduced accordingly. In one instance of a change from 45 to 22½ deg, with a minor change in block centers, the weight to be supported was cut to one-third of the total under the 45-deg plan previously employed.

Whether short lines or stepped lines are feasible is another question in projection. Each case must be studied individually but there are instances of successful operation with very short lines. Also, there are instances of steps of considerable magnitude in lines as a result of permitting entry recovery to lag behind to provide room for a tail track, as well as permitting one group of rooms operated by one mining unit to get considerably ahead of the next group. The conclusion therefore is that with most top there is considerable flexibility in establishing and operating pillar lines, though, other things being equal, a reasonably long straight line normally provides the maximum results with a minimum of trouble. And whatever the system, a cardinal rule is getting the coal out clean or making sure that any pillars or stumps that cannot be recovered are shot before they are left. Much of the trouble on pillar lines results from forgetting this rule.

Preventing Bumps—In brief and perhaps oversimplified terms, bumps are the result of a concentration of stress in the interior of a block or blocks of coal as a result of weight. As the weight builds up, the coal in the pillar is stressed more and more, until it suddenly fails in explosive or semiexplosive fashion.

Preventing weight buildup is a combination of a number of things as outlined in a more detailed discussion of bump prevention in the section on "Roof Support," p 29. Careful study will permit evolving a mining plan which will eliminate or reduce load buildup of the type which results in bumps.

In addition to mine layout, pillar design and pillaring system, bumps may be avoided by drilling or augering suspected pillars. In this process, the weight is unloaded gradually, or the bump is triggered while the weight concentration is small and before actual mining of the pillar starts. For a fuller description of the pioneer drilling and augering plan for bump control, see *Coal Age*, January, 1955, p 68.

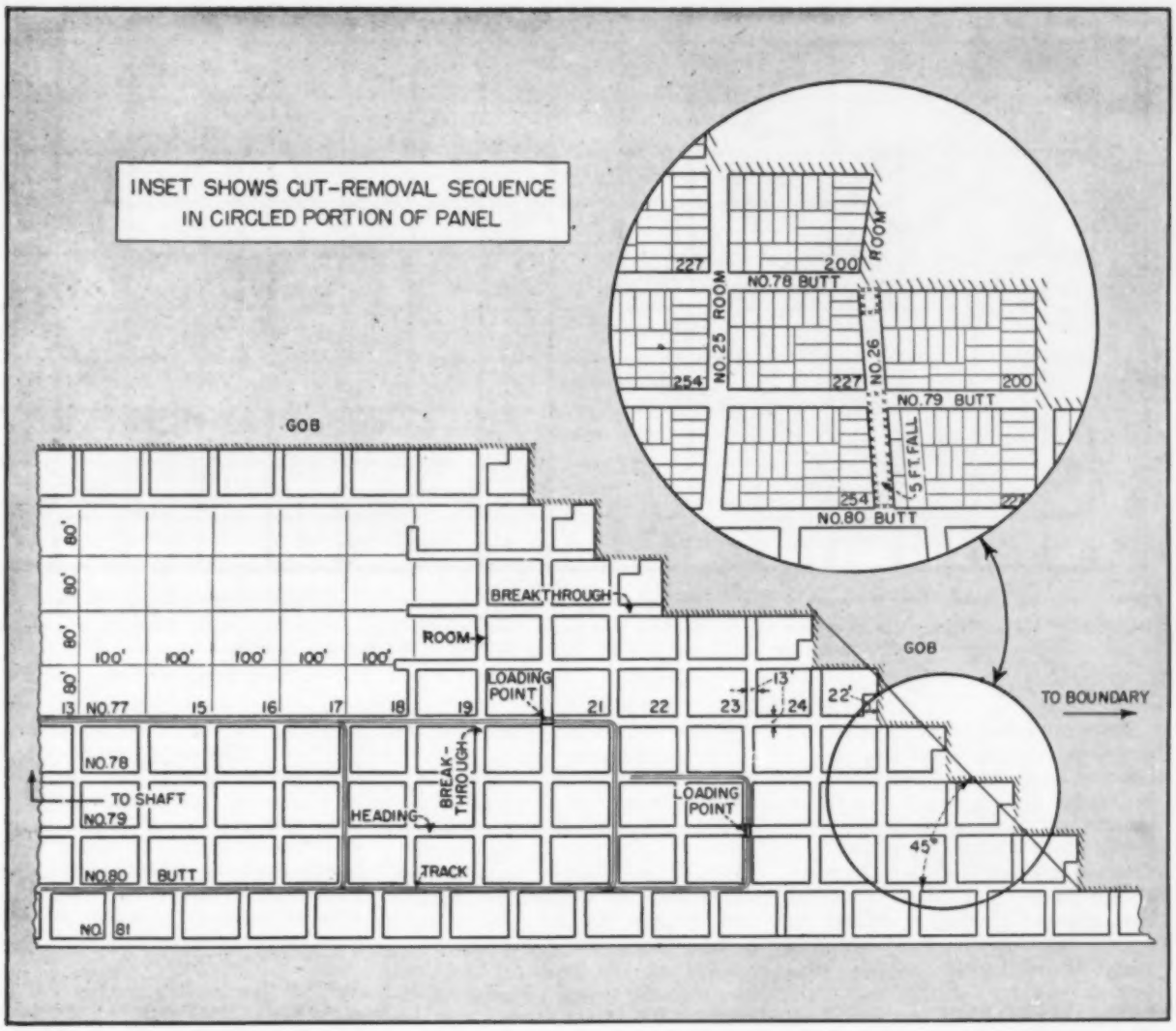
MACHINE PLANS

A key factor in efficient machine loading is coal and transportation at all times. An adequate coal supply requires, among other things, an adequate number of places in which to work. The basic rule is that as soon as the machine is finished in one place coal should be ready in the next for loading. Acceptance of this rule means that with conventional room haulage—usually the shuttle car—the minimum number of places usually is four, exclusive of crosscuts. In the past, however, some operators have approached the question from the standpoint of high tons per man from a small crew in two to three places. If tons per man are high enough, they compensate for the fact that fewer tons are secured per dollar of investment in machines. New equipment, on the other hand, removes this objection to a small number of working places. The bridge conveyor is an example, but even with it there should be enough places so that the loader never has to wait for coal.

Shuttle-Car Haulage—Though there are many variations, the section layouts for shuttle-car haulage tend to be one or the other of two types:

1. The panel plan with rooms turned both ways and driven in groups of 5 to 7 or more. One reason for the use of this plan is the fact that pillars are not recovered. However, with modifications, pillaring can be done with this plan also.

2. The conventional block or room-



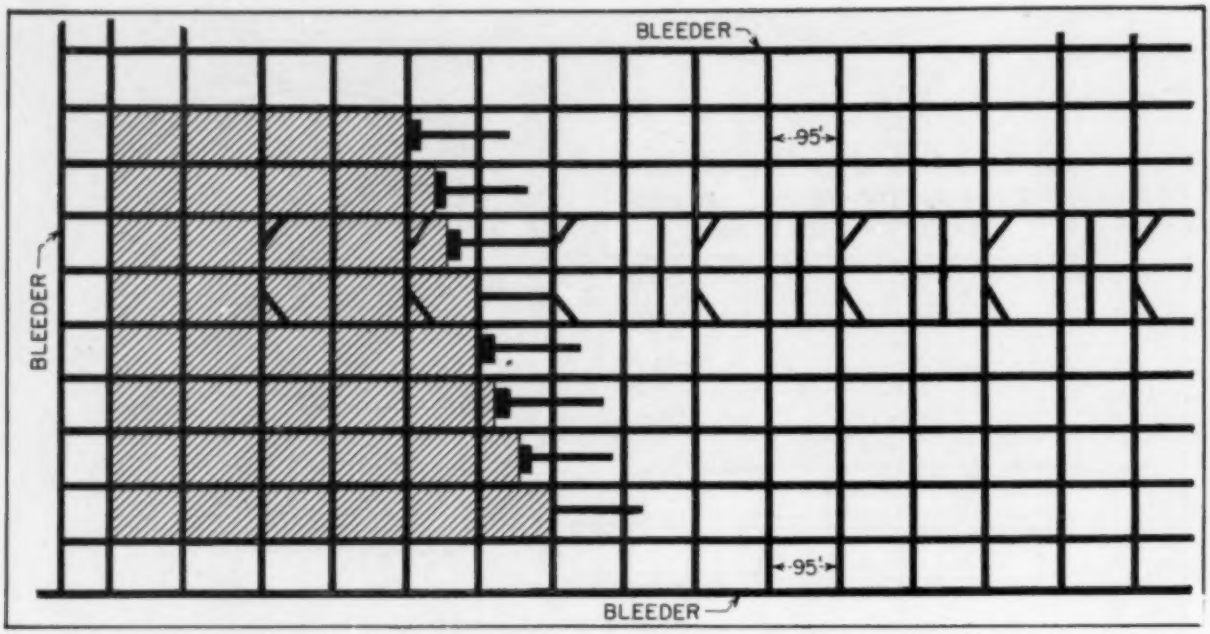
LOOP CIRCUITS simplify rail haulage and keep cars right end to in this block plan for shuttle cars. Pillars are open-ended in numbered sequence to provide close control of breakline. New places are developed only as necessary.

and-pillar plan devised for pillar mining, either with short lines for each room section or longer lines advancing continuously from section to section. To facilitate the latter, some block plans, as noted elsewhere in this section, are set up with all openings on the same centers so that pillar lines can be established and advanced without having to shift gears when an entry is crossed.

In developing for both plans, the usual practice is to drive a minimum of 4 or 5 headings to make entry work as near like room work as feasible and thus as efficient as possible. Heading stations are established every 200 to 300 ft, at which distances the shuttle-car haul is kept under the generally accepted maximum of 500 to 550 ft. If track is used, it may be looped completely, or may be turned into a room or back down the next heading to establish a tail track for transfer from shuttle car to rail car.

Crosscuts may be angled each way from the center heading to facilitate higher-speed shuttle-car operation. This is especially true in operations based on mining individual panels, and particularly where pillars are left. In some plans, the angle crosscuts continue to become rooms, with angling continued in making room crosscuts. In a group of five or more rooms, for example, the center usually becomes the key room, often leading directly to the car or belt-loading station. An example is shown in the accompanying plan, with four rooms on each side of the key room and track in two headings for fast handling of trips with a minimum of stoppages in loading.

Two other plans accompanying this section show right-angle development for pillaring, as well as bleeder headings and loop tracks for loading. One also is an example of how new openings are driven to develop blocks for pillaring only as needed. The record shows bleeder headings protected by pillars, as well as another version of looping of track by angling crosscuts at the desired intervals. With track setups, all shuttle cars normally must dump at the same point. Consequently one must occasionally wait on the other. Where panel belts are used instead of track, however, some operators restrict one shuttle car to dumping at the end and require the other to use a crosscut farther down to prevent interference and loss of time in wating to use the same dumping point. Where possible also, this same separation of routes is carried to the face, except for the opening in which the loader is working.



BLEEDER HEADINGS with flat-angle pillar line and loop track feature this block plan designed for shuttle-car haulage. Blocks are split on retreat and the halves are recovered by open-ending.

Extra-thick coal offers some special problems in machine mining. At one mine, as an example, though the mining system went through a number of changes, all openings invariably were driven along the bottom. Top and rib deterioration and the onset of weight always outpaced the rate of extraction, thereby making it difficult to achieve the desired recovery. The cure was found in driving the openings in the top of the seam and bolting the roof, which permitted fast, economical removal of the lower portion of the pillars by loader or scraper (*Coal Age*, November, 1954, p 92).

Track Haulage—In loading directly into mine cars, maximum efficiency involves these steps:

1. As big a mine car as possible to reduce the number of changes per cut.

2. A one-way distance back to the closest changing point of not over 150 ft.

Prefabricated track provides a reliable means of attaining the second objective, as well as the further goal of track that can be installed, taken up and moved quickly and with a minimum of labor. Prefabricated track also forces adherence to the mining plan, which is helpful over both the short and long pulls.

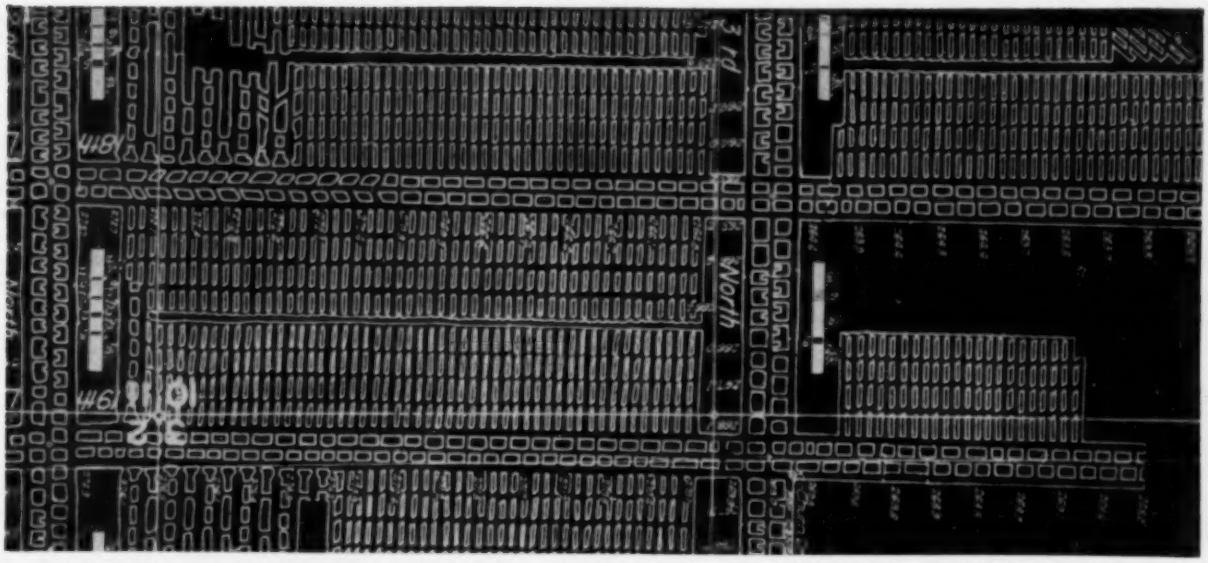
Conveyor Haulage—Being a continuously operating haulage unit, the conveyor was early seized upon for service behind loading machines. The difficulty of keeping the machine discharge over the conveyor, with consequent loss of time by the operator, added to the time and cost of moving the conveyors, resulted in, first, a trend to mine cars and, next, to shuttle cars. New types of units, however, are putting the conveyor back into the loading-machine picture. An example is the bridge conveyor, which is connected directly to the loader to provide a continuous conveying line.

Bridge-conveyor plans normally are based on two or three places per unit. Basic equipment in the unit is two or three room conveyors, two or three bridge conveyors, a cutter and drill in each place, and a crawler-mounted loader, plus mother or cross conveyor, elevator, car-spotting hoist, roof-bolter, rock-duster and so on. The loader moves from place to place, and a mounted cutter may be substituted for the individual shortwalls, alternating with the loader.

Operation is much the same whether rooms or entries are being driven. An entry-driving setup is shown on p 10 of this issue. Average performance in 34-in coal is 20 to 25 tons per faceman. One element in this performance is a tight well-balanced cycle, involving four men approximately 30 min in preparation and two men 30 min in loading, as follows: (1) two men drill two shot holes; (2) two men sump cutter; (3) one man continues to cut while helper and third man drill three remaining shot holes; (4) one of the latter two loads, tamps and prepares to shoot while other sets permanent timbers to replace safety jacks; (5) fourth man installs conveyor pan and cleans up loose coal; (6) face is shot; (7) loader crew of two men loads out the cut. Note that preparation and loading require identical times, meaning no lost time for the loading machine. Steps to achieve this goal include bug-dusters on cutting machines, 8½- and 9-ft cutter bars, and crawler trucks and three-wheeled push carts for handling equipment and supplies, plus loop track to reduce car-change time.

PILLARING PLANS

Loading machines can be used in practically any system of mining individual room pillars, including slabbing and splitting. The two most-used plans, however, are open-ending and pocket-and-stump. A variation of the latter is pocket-and-fender, under which the stump is cut down to a shell only 2 to 3 ft thick. A subvariation is gripping the cutting machine out each time to make a saw-toothed fender and increase recovery slightly. Timbering plans for pillar mining are discussed in the "Roof Support" section of this Deep Mining Guidebook. In open-ending, it usually is best to arrange the direction of advance so that the machine operator is on the side away from the coal and protected from sloughing and rib



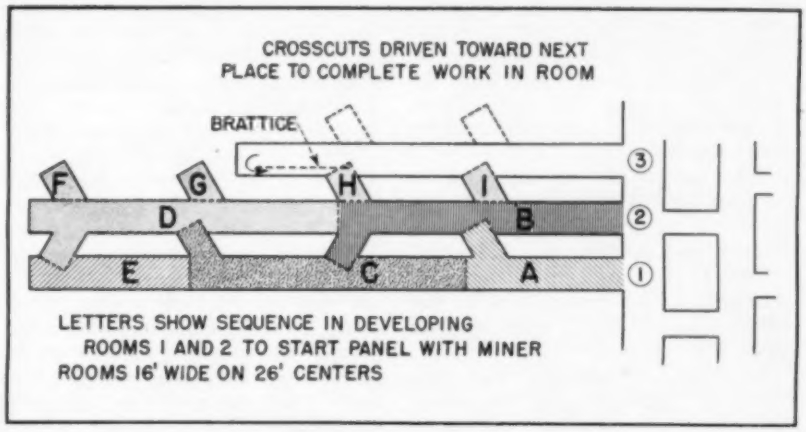
CONTINUOUS-MINING PLAN designed for advance on one side of panel and retreat on other, with short room centers and pillars left in place. Plan below shows sequence of driving and crosscutting in first two rooms to establish ventilation.

bursts, particularly where heavy weight is the rule and the coal is soft.

Continuous Mining

Though much experiment and development remain, continuous mining is beginning to enter the stage of reliable production at maximum rate. One longwall-type continuous unit, as an example, early in July, had completed 170 consecutive cuts for a production of 84,000 tons without an interruption preventing complete cleanup of the wall on one shift. More recently, in thick coal, a new-type high-capacity machine of the conventional type has been flirting with an average of 100 tph—and incidentally with 100 tons per man-shift for the face crew.

As with earlier mining equipment, the emphasis in the United States has been on mobile machines, even though the actual mining principle ranges from ripping to boring. As a result, most of the continuous production comes from room-and-pillar or block systems, modified as necessary to take fuller advantage of the potentialities of the miner. And as with older-type equipment, the machines are used either for room work alone, leaving pillars, or for full extraction, including taking the pillars. The No. 1 problem, as with conventional mining, is haulage behind the miner that will permit it to work the maximum time. The second is roof support and the third is keeping the miner in operation. These problems are treated



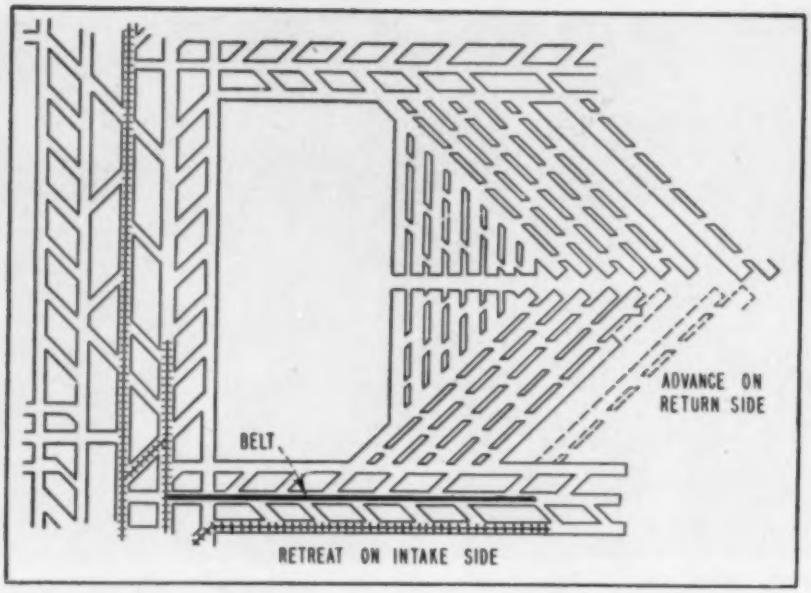
in more detail in other sections of this Deep Mining Guidebook and in the Maintenance Guidebook in this issue.

CONTINUOUS PROJECTION

The mobile design of practically all mining-and-loading, or "continuous," machines used in the United States and Canada has resulted in projections very similar, for the most part, to those previously employed for conventional loading and, earlier, for hand loading. Certain exceptions, used with special equipment, such as the planer, are discussed in the "Longwall" section of this Deep Mining Guidebook.

Even though the plans are generally the same, mining with continuous units differs basically from mining with earlier equipment in that the continuous machine can stay in one place, compared to loaders, for example, and can produce "continuously" from that place, compared to the intermittent production from, say, conveyor places, where the need for cutting, drilling and shooting, even though overlapped with each other and with loading as far as possible, necessarily cannot be arranged so that loading is continuous.

This ability of the continuous miner to get all its tonnage from a single place has, among other things, eased the problems of entry-driving and development in at least some respects. With continuous equipment, only the number of headings required for haulage, travel and ventilation—no more—need be driven. In contrast, with machine loading the number frequently was increased to permit the unit to operate more nearly at potential capacity and efficiency, even though this involved, as an example, more temporary and permanent support,



ANGLE CONTINUOUS PLAN, shuttle-car and belt haulage. Room pillars are left and squeeze pillars are provided at intervals. Rooms are worked advancing on return side of panel and retreating on intake side.

stoppings and so on, aside from the inherent handicaps of operating in places of less than normal room width. Now, with continuous equipment, a number of operators are cutting down on total number of headings in main, cross and room entries. However, if desired, the number may be maintained or increased to fit in with certain types of mining, such as, the block system with all openings and pillar sizes uniform.

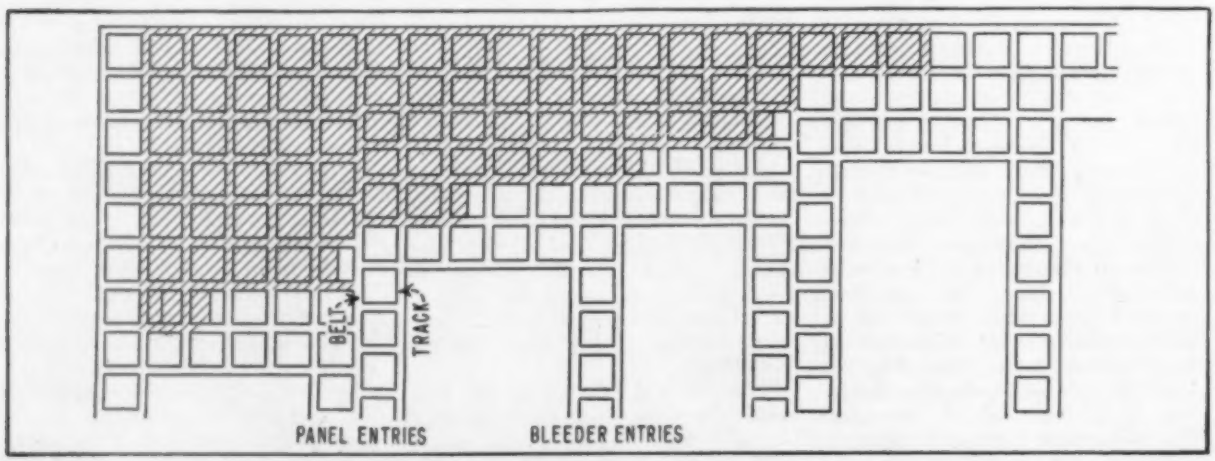
Continuous equipment also provides an opportunity for a concentration of production previously impossible to attain. As an extreme example, all the machines necessary for the desired output per shift may be stationed in adjoining places, and the places may be either rooms or entry headings with no significant difference in output, other things being equal. As an example of such concentration, at one new mine specifically designed for continuous machines, the plan calls for concentrating as many as 12 machines in a single butt or panel entry. One bar to heavy concentrations, however, might be the corresponding increase in the rate of gas liberation, which might make it difficult to get enough air to the points of coal production to keep the percentage below safe limits at all times. High concentration also may add to the difficulties of providing continuous haulage, handling men and supplies, rock-dusting and so on.

With conventional forms of transportation, such as, shuttle cars or standard room conveyors, "room" depth necessarily is much the same as with conventional equipment. New transportation units, on the other hand, such as, the articulated and extensible belts, permit changing projections to provide for "room" lengths up to 1,000 ft. Thus, along with the fact that the continuous unit simplifies the entry-driving phase of development, even fewer entries are necessary with the long rooms.

ROOM SYSTEMS

An example of 90-deg continuous mining with ripper-type machines, leaving thin pillars, is shown in an accompanying illustration. Using shuttle cars and belts, the rooms are mined on the advance on one side, and on the retreat on the other. One feature of this plan is the establishment of the crosscutting pattern with the driving of the first two rooms, as shown. Thereafter, the crosscuts are turned and driven pillar thickness deep on the solid side, while those on the opposite side are picked up automatically as the place advances.

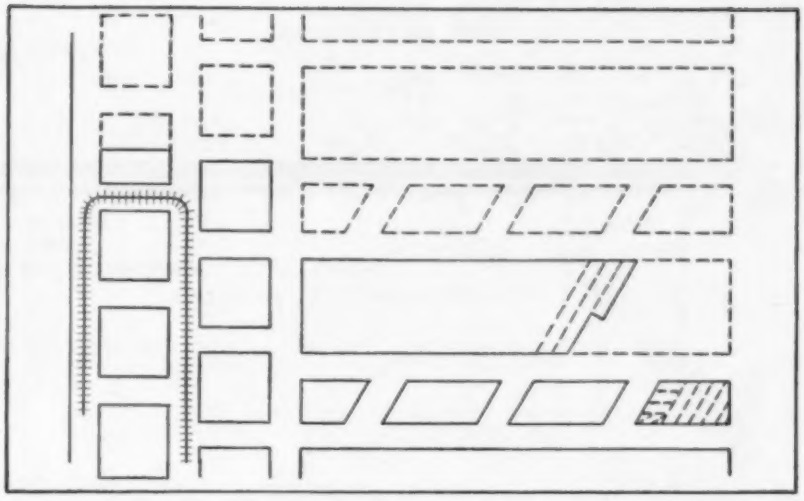
To facilitate shuttle-car haulage to panel belts another user of ripper-type equipment turned places on a 45-deg angle, and omitted every 6th or 7th room to form a squeeze pillar and barrier. Rooms are turned both ways from the three-heading panel entry, which leaves a triangle between the outby ends of adjacent sets of entries. This triangle is mined by turning sub-rooms, again at 45 deg, off the No. 1 room on each side. The panels are "closed" in that they are surrounded by solid pillars except



BLOCK-TYPE CONTINUOUS PLAN, with stepped pillar line and bleeder entries between panel entries. Pillars are removed by splitting and then pocketing through the halves, leaving small fenders.

where the panel entries come in. Rooms are worked on the return side of the air current on the advance, and on the intake side on the retreat out of the panel.

A modification of this system to permit using the extensible belt consists mainly of cutting the number of rooms in a group to five and making them 600 ft long. The three headings making up the room entry are driven with shuttle cars, with crosscuts at 45 deg from the room face to the panel belt. Each of the five rooms in a group then is driven separately, advancing on the return side of the panel and retreating on the intake side.



ANGLE PILLARING PLAN for rigid-head miner is based on solid pillars between pairs of rooms.

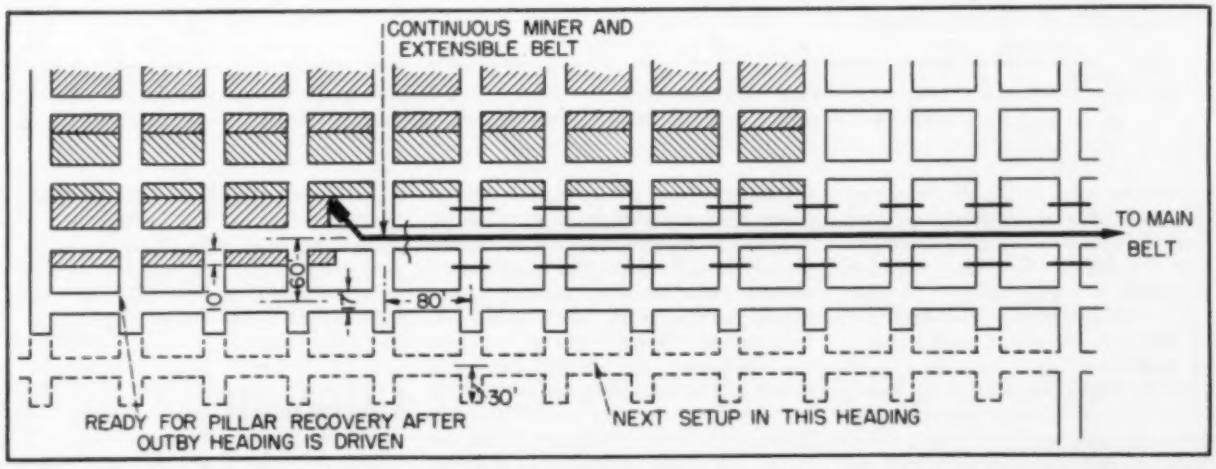
PILLAR SYSTEMS

Projections for continuous pillar-mining systems, as for room systems, are as previously noted, fairly similar to those for machine and hand loading. The major difference to date seems to be in a tendency toward blocks rather than long rectangles, and toward flat or low-angle pillar lines rather than the conventional 45 deg. Stepped lines also are more frequent, though the internals seldom are more than the equivalent of one or two pillars or blocks. Width of a step seldom is more than 3 or 4 places, and in some instances is only one. Steps in lines pose the same problems of weight on projecting points as weight on stumps in a standard 45-deg line (see "Machine Projections" in the section on "Machine Mining"). However, as noted, many operators are finding them helpful as well as satisfactory where top is good and weight on points is not excessive.

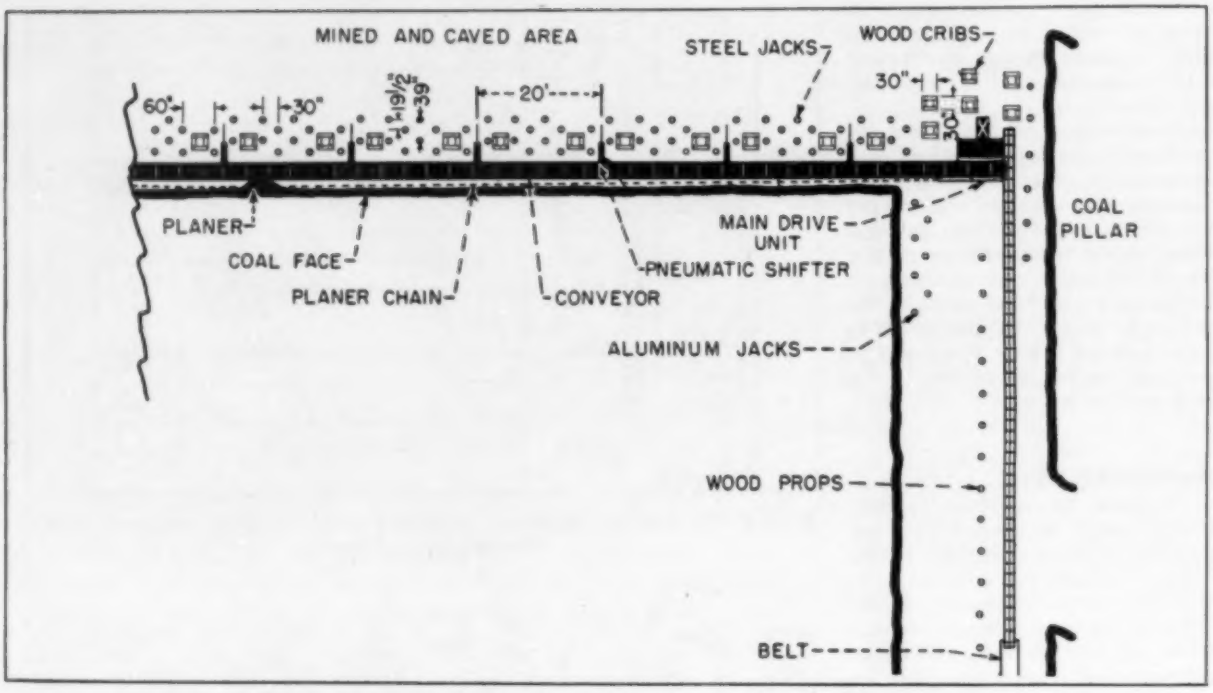
Even with the so-called "rigid" machines, the tendency is to put continuous-mining work on 90 deg. Where, as is usually the case, the pillars are square or nearly square blocks, the general practice is to split them, and then open-end the two wings, with or without leaving a small triangular stump or peg next to the gob where the lift is started. However, some angle plans are worked. An example is shown in an accompanying illustration. It involves driving pairs of rooms on short centers, leaving a fairly thick solid pillar next to the gob. The miner is a boring-type unit, and both the solid gob pillars and the room pillars are mined by open-ending at angles of 45 to 60 deg.

With the conventional rectangular pillars, the usual practice is to take lifts off the gob end, either with or without leaving stumps, pegs or fenders, protecting the equipment and unmined coal with conventional breaker sets. Lift length is a consideration in fixing pillar size for best results. Short lifts require more frequent moves, especially in thin coal, whereas extra-long lifts, especially if open-ending is the practice, increase the hazard of losing the face, damaging or destroying equipment and injuring men. If practice to date is an indication, the best length of lift seems to be around 30 ft in thicker coal, running up to 80 ft or so in thin coal with reasonably good top.

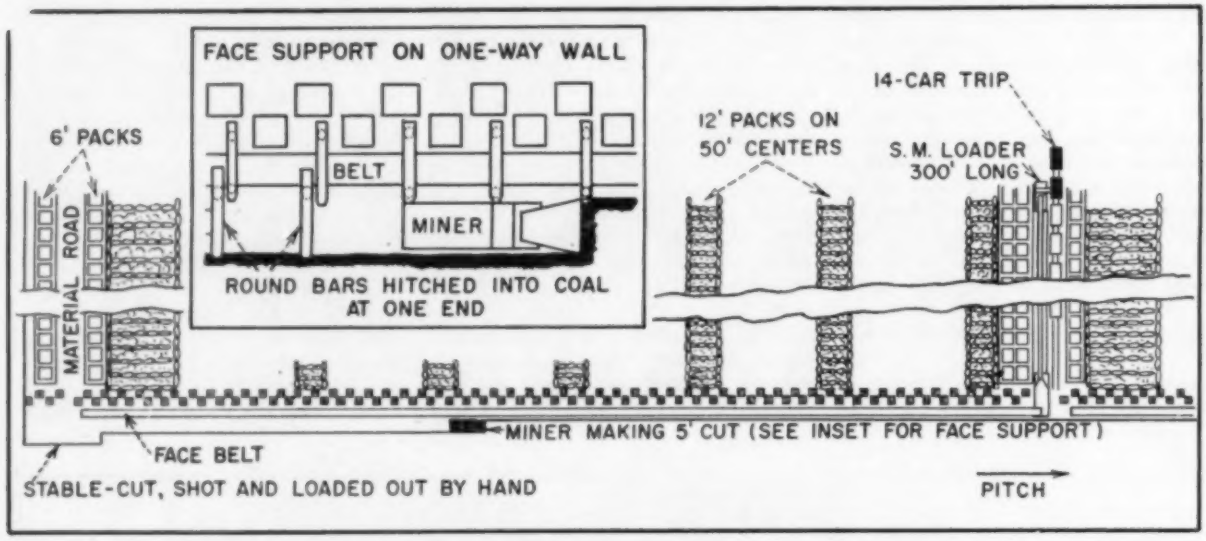
Lift width in open-ending with rigid or semi-rigid machines normally is head width, compared to width-and-a-half or double width in room and crosscut work. Pocket-and-stump or pocket-and-feeder recovery, however, eliminates the open side. There-



EXTENSIBLE BELT permits driving places 1,000 ft deep with continuous miner. The pillaring plan shown is one of several designed to take advantage of extensible-belt characteristics.



COAL-PLANER SETUP on wall in thin coal, with roof control by steel jacks and wood cribs.



PITCHING LONGWALL FACE under heavy cover, with special ripper-type miner discharging to face belt. Main support is packwalls and cribs. Face support is round bars hitched into the coal.

fore, as in room work, the tendency with these types of pillaring is to drive width-and-a-half or double because top conditions or gas emission may make it undesirable to advance single width past the operator's station without advancing roof support and brattice.

What might be called "special" systems for pillar extraction with continuous miners includes one worked out for ripper-type machines with extensible belts (*Coal Age*, July, 1955, p 50). As indicated in the accompanying illustration, places are 1,000 ft deep, and the development plan is based on keeping an open place ahead. Thus, in the active pillar place, all the pillar on the gob side is removed and a 10-ft cut is taken off the opposite side, working back to the mouth of the place. Then, the miner and belt leapfrog the next place (previously driven to its limit), and drive a new place. When it is driven to its 1,000-ft limit, the head and tail sections of the extensible belt are trammed back to the place previously leapfrogged. The intermediate sections and belt are left in the newest place for use in pillar recovery. This cuts time to put the belt into operation to a minimum when the head and tail—and the miner—are trammed in for pillar recovery.

Longwall

Roof control is the heart of longwall mining and requires not only special support systems but also con-

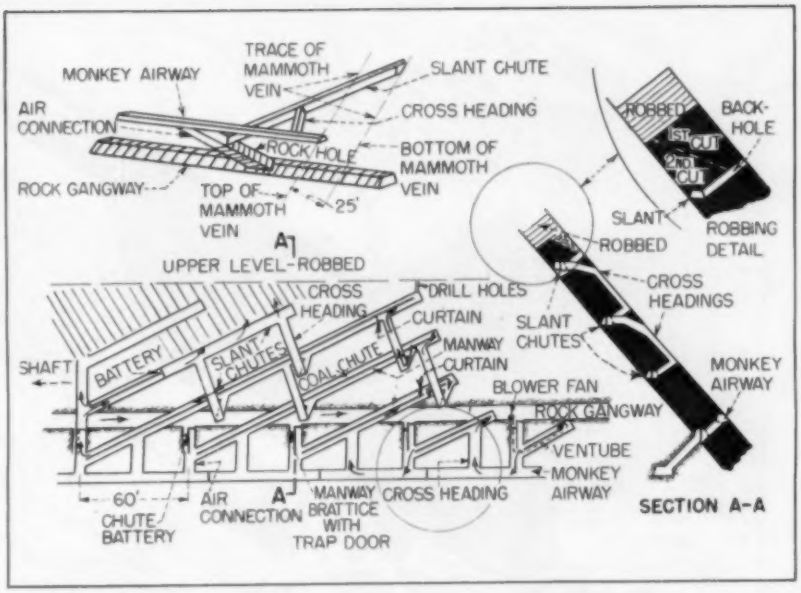
siderable specialized experience, compared to the conventional room-and-pillar system. Also, the usual type of equipment designed for room-and-pillar and properly operated gives such a good account of itself that longwall finds it difficult to compete in the thicker, flat seams. This is especially true with the conventional types of continuous miners which, in effect, convert room-and-pillar into open-end longwall.

For these and other reasons, longwall in the United States and Canada is so far limited to thin or pitching coal, as a rule. Also it is largely limited to special types of equipment, such as, the stripper or planer, or special ripper equipment operating open-ended. However hand-loaded conveyors and self-loading scrapers still are used on faces established between pairs of entries or by slabbing rooms. Slabbing to remove a thick solid pillar by widening the original room also may be done with loaders served by shuttle cars discharging to mine cars or a panel belt (see *Coal Age*, June, 1953, p 84, for example). In most slabbing systems, solid pillars are left at intervals, and thus the advance of the face is intermittent.

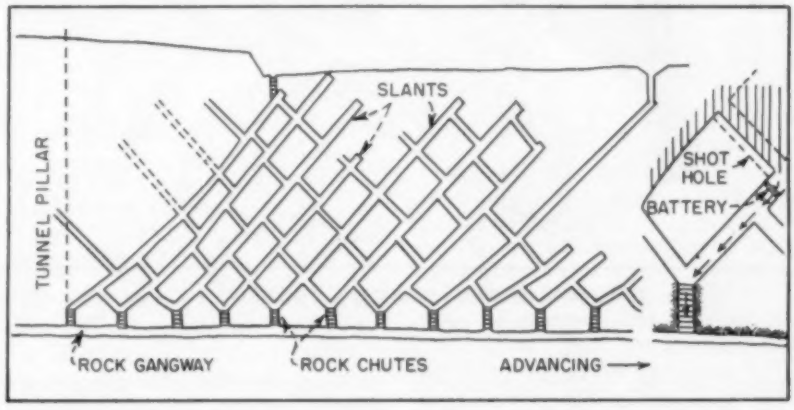
An example of a longwall face designed for planer mining is shown in an accompanying illustration. Face length is a little over 328 ft, and average production per shift in 34-in coal is over 400 tons, with the maximum approximately 700 tons. Including development, average tons per man-shift is over 13, or about one-third more than with conventional mining. The aim in roof control is to cave the top behind the face while keeping the face open by means of cribs, steel props and steel headers.

A second illustration shows a face designed for a ripper-type longwall unit under heavy cover requiring packwalls. The walls are established up and down the pitch and the miners operate on pitches up to 18 deg. Length of a wall is approximately 500 ft, or no more than a machine can clean up in a shift. This is necessary because conditions are such that all supplementary work—advancement of conveyor, packwalls and face support—must be done on the offshift, and failure to complete the cut would mean losing a day in the production cycle. On light pitches the machines cut both ways. On heavier pitches, it cuts downhill only and is trammed back to the top of the wall on the offshift.

Originally, the miner discharged to a belt conveyor alongside. "Python"-type flexible chain conveyors are being substituted for the belts, and are



SLANT-CHUTE SYSTEMS (above and below) are examples of plans devised to reduce manual labor and raise efficiency in steep-pitch mining. In line with general practice today, gangways are driven in rock under the coal.

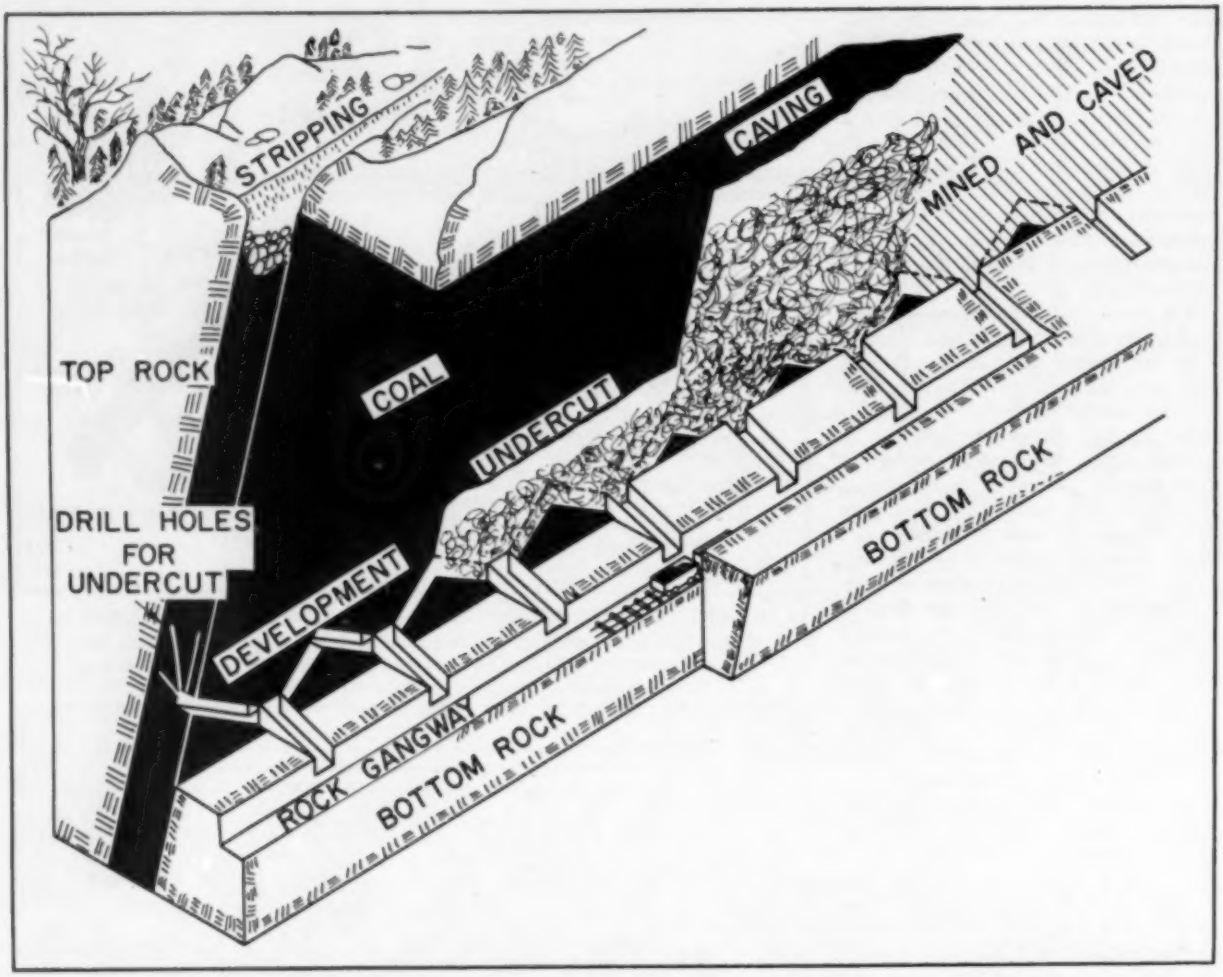


pulled over by the miner itself as it returns to the top of the wall in the heavier pitches, thus releasing a conveyor-moving crew of 8 men for other productive work. An incidental benefit is an increase in wall production by eliminating the spillage encountered with belts. On some of the longer walls, this runs to 30 to 40 tons per shift.

Theoretically, longwall provides the maximum in continuity of production, but roof control normally requires more support and more labor to install it, in addition to other special requirements and facilities. Thus, as noted, it finds it difficult to compete with conventional equipment in thick, flat coal. However, particularly where thinness or pitch prevent the use of conventional equipment, the continuity of production with longwall methods and modern longwall units normally—though not always—more than offsets the cost of extra support and facilities, with resultant significant increase in tons per man. Thus, one planer in 3-ft coal has raised output per man-shift to the parting 2 to 4 tons compared to production with conventional methods, while the ripper-type pitch unit has gone over 600 tons in a mining shift with tons per man to the car-loading station, loading shift only, of over 50. Average mining height is approximately 4½ ft.

Pitch Mining

Pitch mining may be defined as mining on grades greater than those that can be negotiated readily by mine cars or shuttle cars, or around 5 to 6 deg. The maximum on which crawler-mounted equipment can be moved without too much difficulty is



ORIGINAL INDUCED-CAVING CONCEPT for mining steeply pitching anthracite veins.

around 15 deg. Light-pitch mining may therefore be defined as mining between 5 and 15 deg. Heavy pitch may be defined as the degree of pitch at which the coal will run on the bottom. This normally is something over 35 to 40 deg. By elimination, therefore, the moderate-pitch area becomes that between approximately 15 and 40 or 45 deg.

LIGHT PITCH

Practically any type of equipment may be used at the face of places driven either up or down light pitches. Normally, however, some form of conveyor is necessary for transportation. With this limitation, all the ordinary panel plans, with or without pillaring and practically all the conventional face equipment may, as noted, be employed. Usually, particularly as the pitch increases, the practice is to put headings up, down or both—usually up—and rooms across the pitch. Among other things, this permits the use of shuttle cars on pitches up to 10 to 12 deg or perhaps slightly more, the cars discharging to either a lowering or hoisting conveyor relaying the coal to the main-haulage system. Angle crosscuts between places permit easier movement of units from place to place in conventional machine loading.

MODERATE PITCH

Galvanized iron kept wet provides perhaps the flattest gradient on which coal will flow of its own accord. The minimum is around 20 deg. At about 25 deg, coal will begin to flow on ordinary iron, and at something around 35 deg, on wood. Below, approximately 20 to 22 deg, therefore, it normally is necessary to install conveyors to move coal down the pitch.

Where pitches of this degree prevail, customary practice is to sink belt or rope slopes, turn gangways right or left on a grade rising slightly to facilitate water flow, and then work rooms up the pitch, using hand labor to get the coal to the conveyor or chute. Modifications, however, include a few plans for crosspitch room work. One involves driving a pair of rooms up a 45-deg pitch and installing in one a timber track with hoist, a ladder and a chute. Rooms are turned 90 deg across the pitch, and a shaker is installed along the lower rib of each one, with a second pan line along the upper rib which serves to bring in supplies until it is called upon to bring out the room pillars above it.

Light- and moderate-pitch plans also include the longwall system with ripper-type mining unit discussed in the previous section on "Longwall."

HEAVY PITCH

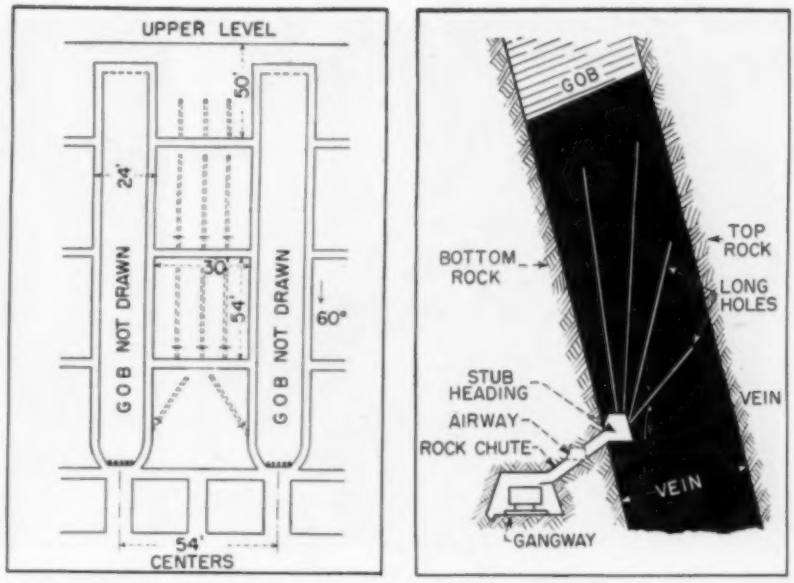
Attempts to eliminate the high percentage of hand labor necessary in steeply pitching seams have been only partly successful, though the introduction of longhole drilling is beginning to alter the picture substantially. It too, however, requires a fair amount of hand labor in driving

openings for air and for preparing the sites and faces for longholing, though not as much as previous systems.

Initial longhole experiments go back over 20 yr in the anthracite region, with a lapse of over a decade after the first trials. Meanwhile, to alleviate the labor and difficulty of advancing breasts straight up heavy pitches, attention was concentrated on plans which would cut down the pitch of openings in which men had to work to that on which coal would run on either iron or the natural rock, meaning to a minimum of 35 to 45 deg. The "lattice," "diamond," "slant-chute" and other similar plans were evolved, differing largely in details—for example, 30-deg openings, with sheet iron and without batteries in one "diamond" plan, compared to 45-deg openings, no sheet iron and batteries at intervals in one "slant-chute" system. In both, the openings are first developed to the old gangway above and the pillars are recovered on the retreat back down. Usually, one-third to half of the pillar is drilled with holes up to 45 to 50 ft, loaded with explosive placed with detonating fuse to insure complete detonation, and shot. The coal then flows to cars in the gangway, controlled as necessary by checks or batteries. In the slant-chute system a new battery normally is built immediately below each time a new section of pillar is shot.

Because life usually is long and disturbance in the vein can be substantial after mining gets well started, the trend is toward gangways in the rock under the vein, with rock chutes up to the coal. This leaves a strip of coal between the rock gangway level and the top of the rock holes. This strip may be recovered from the next gangway below, or short, level rockholes can be driven to the vein, which then is opened up by chutes as necessary and then drilled and shot into short conveyors leading back to the rock gangway.

Induced Caving—Another proposal for reducing labor in mining heavily pitching veins is "induced caving." Similar in principle to "block caving" in metal mining, the system has shown promise in its initial trial. The original idea, as developed by the Bureau of Mines, is shown in the accompanying illustration. It involves a gangway in the rock under the vein, rock holes up to the coal, slant shutes between rock holes in the vein, and undercutting of a section of the vein by drilling and shooting to induce caving, with the coal drawn off through the rock chutes as caving progresses up to the surface or the old level, unless rock dilution becomes excessive. Production in the initial experiment was 33.5 to 38.8 tons per man-shift.



TWO LONGHOLE PLANS show (left) development along general lines except that pillar size is increased to permit drilling and shooting, and (right) operating in nearly vertical vein with only drill headings in the coal.

LONGHOLING

Variations in longholing methods largely reflect how much preliminary development work is done. As an example, in moderate pitches, the conventional chambers and crosscuts may still be driven, the principal change being an increase in the size of the pillar left. The pillars then are drilled and shot instead of being mined in the ordinary way. Holes therefore are seldom more than 50 ft long. An example of plans where the emphasis is more on drilling of pillars formed along conventional lines is shown in the accompanying illustration along with an example of longholing with a mimimum of development.

Longholing with minimum development at one operation, as an example, is based on gangways and airways in the rock beneath the vein, with rockholes to the vein at intervals fitted with batteries to control coal drawoff. Holes drilled back from the next rockhole and cased with pipe insure positive ventilation behind the battery both before and after shooting. Holes also are drilled to next level above to drain off any water that may have accumulated.

Longhole drilling is done from a heading in the coal. To start a section, two places are driven up to the old workings and the chain pillars are removed to provide expansion room for the coal to be shot. Then the coal between two rock holes is shot by three groups of three holes each, one parallel to the bottom, one angling up through the vein and one directly toward the top rock. Firing is done on off-shifts or idle days.

Dos and Don'ts—Use close-fitting joints to prevent hole drift. Check to make sure any water above is drained out. Check to make sure no charges are set off in gas. Make sure detonation is complete to eliminate possibility of burning explosive igniting coal. Clean holes thoroughly. Use plastic-type explosive and keep quantity per load down to avoid spreading of lower stick in charging. Arrange for positive ventilation with good control at all times. Make all openings used for drilling large enough for comfortable, convenient operation.

BORING CROSSCUTS

One of the more aggravating and expensive items in gangway development in coal in moderate to heavy-pitch mining, is crosscutting between gangway and airway. The big drill is one answer. Size may range from 24 to 42 in, and one, two or three holes may be drilled up the pitch to get the required crosscut area. In contrast to an earlier version (*Coal Age*, May, 1951, p 100) a new and much-lighter type (*Coal Age*, August, 1955, p 58) employs a hoist and rope to pull the big bit through a pilot hole. Another advantage of the bored crosscut is that a simple disk rather than an expensive custom-made stopping can be used to close it.

NEW AIDS TO HIGHER EFFICIENCY in face preparation include (left) the flexible-shaft drill operated from power takeoff on cutter and (right) the hydraulic hand-held drill receiving power from cutter hydraulic systems or special pump.

Face Preparation

MAXIMUM RESULTS in face preparation are attained only by constant study of cutting, drilling and shooting, including equipment, bits, placement of cut or cuts and placement of holes. The goal is maximum output by the loading unit, whether man or machine. When this is attained, tons per man engaged in face preparation is higher, expenditures for explosives and detonators are lower, and safety is advanced.

Bits—Both their own cost and their effect on productivity, plus, even, their effect on the size consist of the coal, make bits important. Sharp bits of the proper type, for example, can make a noticeable difference in realization by decreasing the percentage of extreme fines. They also reduce the power consumption in cutting.

Under some conditions, the old carbon bit, forged and quenched, can give a good account of itself. However, these situations are growing fewer, and the need for greater capacity with fewer interruptions for replacement and sharpening has resulted in the development of throwaway, hardfaced and carbide-tipped bits for both cutting and drilling. They sometimes run for days before changing and resharpening are necessary. Some designs can double in brass—for example, drilling first coal and then drawslate where it is taken down for height or for safety; or cutting in either coal or partings if required.

Aside from the desirability of keeping all possible metal out of the coal, insert-type bits cost considerable money in themselves. The rule, therefore, should be an old bit or a thorough accounting before a new bit is issued. Establishment of fixed quantities in the hands of each cutting, drilling or continuous-miner crew—or at least in each section—supplemented by regular inventories will help keep down losses. Grinding to restore bits to service condition also can materially offset cutting qualities and the total number of regrinds, meaning service life. Manufacturer's recommendations should be the guide.

Cutting

The shortwall and the rubber-mounted universal machine are the predominant cutter types today, with the latter accounting for more and more of the total tonnage because of flexibility, greater mobility and higher capacity. The shortwall, however, still dominates in conveyor mining, particularly in thin coal, and also is a part of mechanical units in thick coal at a number of mines. Hydraulic tilting makes it easier to use and adds appreciably to capacity where the cycle is tight. Bugdusters can materially reduce labor and normally make it unnecessary to clean the kerf. Otherwise, kerfs should be cleared of cuttings to promote safety in shooting, reduce powder consumption, prevent "hung" cuts and generally improve loadability.

Long bars are a distinct advantage in machine loading, since the more tons per fall the fewer the time-wasting moves the loader has to make. Cutting with a long bar, however, requires greater operator skill and increases the risk of striking undulations in the bottom and top, as well as the risks of fouling and binding. If they replace shorter bars on an existing machine, care should be taken to make sure that the motor can carry the extra load, either as is or with improved insulation.

CUT POSITIONING

Simplicity, ease and custom are behind the preponderance of undercutting, which has the further slight advantage that the fall helps to break up the coal. However, it normally necessitates shooting against the top and thus, where this results in serious deterioration, has led to top cutting. Cutting at other horizons may be done to get into softer zones, but usually is adopted to remove bone or rash. Where the latter is the goal, two or three cuts may be taken—or one regular cut may provide enough loosening and relief that most of the remaining material can be raked out.

PROTECTION AGAINST DAMAGE OR LOSS enhances benefits derived from using modern drill and cutter bits. Here, drill-bit protection is assured by wooden holders placed in lunch boxes carrying section numbers.

Cutting under a middle parting in thicker coal may be done as one step in bench mining, the lower bench being shot up and loaded, followed by dropping and disposing of the parting, and shooting and loading of the top bench. Very infrequently, cutting may be done in rash or soft clay under the seam, or in soft material above, either to keep the kerf out of the coal or to eliminate hazardous or troublesome top material. However, such selective mining is on the decrease and the trend today is toward full-seam extraction, including, in some instances, top stone or drawslate. This system relies on mechanical cleaning on the surface for removal of the impurities, since it normally results in a lower over-all cost.

Special goals in cutting include adjustment of undercutting, where the bottom is soft, to provide a good coal pavement for the operation of shuttle cars and other equipment.

SHEARING

The vertical cut, or shear, provides an additional free face, or faces, and is highly valued by many operators as a means of reducing explosive consumption, raising coarse-coal yield and increasing loadability, even though it does result in more bugdust. In permanent headings, some operators have sheared both ribs to keep them free from shooting shock and thus postpone and reduce falls and sloughing.

Since shearing takes time and, as noted, increases the output of cuttings, shear cuts normally are limited to one —usually at the side in headings or other narrow openings, and between one-third over and the center in rooms. Partial shearing, say in the bottom bench, has been done at times, either to reduce the production of cuttings or to avoid, for example, a high-sulphur top band.

Drilling

Depending upon conditions and personal preference, operators have a wide choice in drilling equipment, including not only pneumatic equipment but also hand-held, post-mounted and mobile units. The latter may be designed with one or two arms, with hydraulic auger drive now coming to the front for greater capacity and flexibility. Hydraulic drill-positioning frequently can release one man from the crew for other productive work.

Hand-held units driven either by flexible shafts or hydraulic motors are a relatively recent addition to the types of drilling machines available and in some instances have successfully challenged even large mounted units. Light weight, high speed and operation from the cutting machine through either a mechanical or hydraulic take-off are among the secrets of the machines' success. Where the cutters do not have a hydraulic system, certain operators have found the drill benefits sufficiently large to warrant installation of a special portable hydraulic power unit.

Augers—The "conveyor" auger or approximations thereof now has taken over to a considerable extent from the old twisted auger in coal drilling. Advantages include greater rigidity, with consequently less whip, and more resistance to bending. These features are especially valuable with hand-held flexible-shaft or hydraulic drills, where whipping or a bent auger is especially noticeable. Better hole cleaning also is an advantage, particularly where large holes are necessary.

Shooting

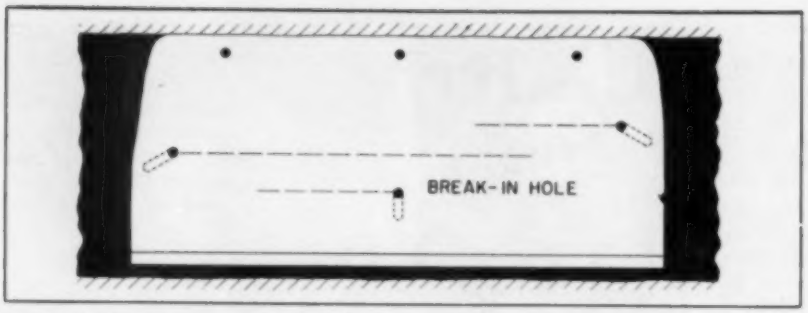
A wide range of explosives and several breaking devices are available for the operator's choice in coal breaking. The breaking devices include carbon-dioxide, air and chemicals, all basically relying on building up pressure in a tube against a disk which ruptures at a certain limit to release the gas or air and break the coal. Air is the most-used non-explosive breaking medium, and the practice for some time has been to supply it from central stations on the surface, sometimes supplemented by large portable or semi-portable units underground at strategic points.

As a rule, carbon-dioxide, air and chemical breaking require a greater number of holes because the maximum force is less, though some operators get by with no increase and many with only a small rise in number. Any increase or other extra expense normally is more than offset by an increase in coarse-coal yield, or by other benefits, including ability to break coal on shift where all other shooting or breaking is forbidden.

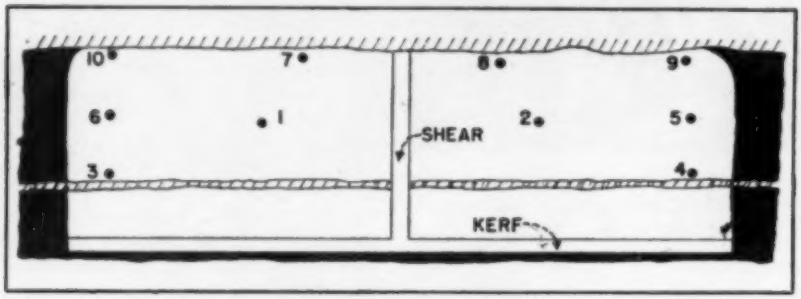
To get the effect of a slower action with powder, some form of "cushion shooting" may be employed if other conditions are favorable. The air space around the charge may be secured by increasing the size of the hole or by placing the charge or stemming to leave an air space ahead or behind. Caution must be exercised to see that cartridges are not separated, thus setting up conditions favoring possible misfires.

HOLE PLACEMENT

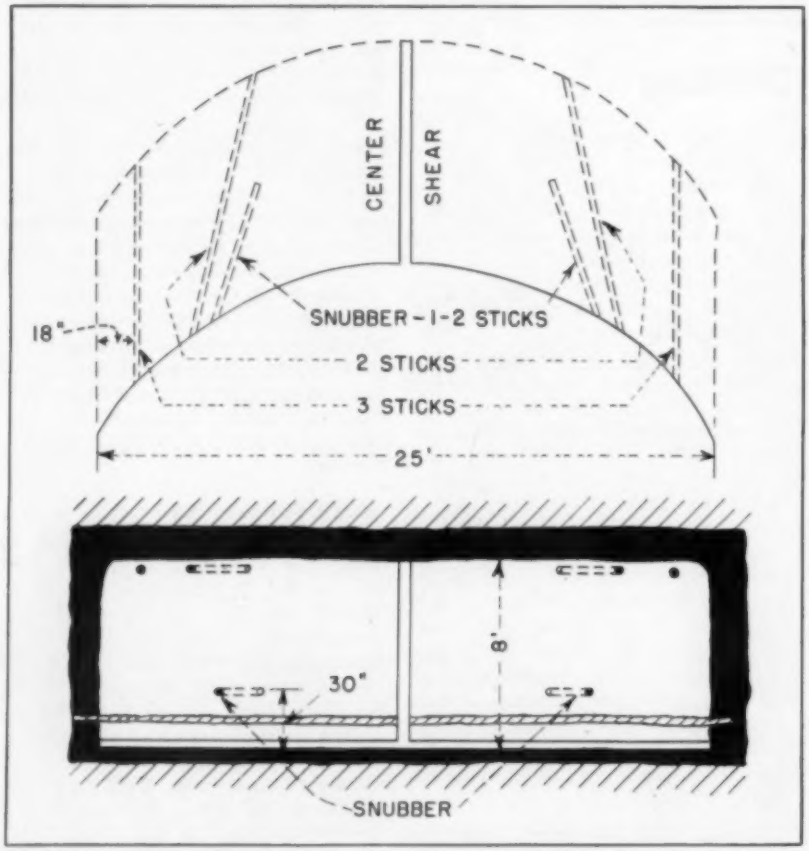
Shooting patterns are almost as numerous as coal mines. Normally, the best pattern for any mine can be determined only by careful study and considerable experimentation. One basic principle is that each hole should "relieve" the next. A second is that the burden on each hole should be adjusted to the maximum charge that can be loaded, though this maximum does not have to be the legal maximum. Consequently a common pattern is a row of holes in the top in thin coal, or in the top and middle in thicker coal, wth the center hole shot first in the bottom row in two-row faces, and in the top row in one-row faces.



BREAK-IN HOLE provides additional free face for succeeding holes. In this plan, lower rib holes are stepped up to break lower part of face in sections.



EQUALIZED BURDEN is goal in this hole pattern in a center-sheared place, thus getting good breakage of coal and band with minimum expenditure of breaking medium.



SHORT SNUBBERS break band and roll out front of fall in arc-cut center-sheared place. Shearing and snubbing reduce total holes and explosive charge to a minimum.

Modifications are numerous. One, as an example, is a row of holes immediately over a slate parting low in the seam to smash it and relieve the regular holes. Another is the snub shot, which may be a full-length hole in or close to the center to knock down the lower part of the cut and open up the face for the subsequent holes. As a variation, the snub hole may be drilled only part way in to break down and roll out the front of the cut. Bottom and snubbing holes may be angled down to get better breakage at the back and more force to kick the coal to the front.

Concentration may be sought for or avoided. As an example, the benefits of drilling a smaller hole may be more than offset by the stringing out resulting from use of smaller cartridges, thus preventing sufficient concentration of force to break the coal properly and economically. On the other hand, concentrating the force at the back of a deep cut in thin coal may result in the charge breaking down to the kerf in the back and leaving the front standing. One remedy is a slower-acting medium strung out over more of the hole.

CHARGING AND FIRING

Stemming always is used with conventional explosives, but normally not with steel-tube blasting devices. However, instead of stemming, safety regulations in some regions require setting safety barriers or deflectors against each hole or the entire face to eliminate flying tubes. In lieu of conventional stemming, blasting plugs may be employed with explosives. Time saving in acquiring, distributing and applying stemming material is one of the benefits.

Single-shot firing with electric detonators still is the predominant system in the coal mines. However, it has definite disadvantages, one of which is the fact that the shotfirer is constantly exposed to the hazards of loose roof and must work in considerable smoke and dust in connecting to each charge after the first. As a result, there has been a substantial increase in millisecond delay ignition of shots in sequence. There is equal safety in relation to gas and dust, less chance of overbreaking exposing charges, less shock to the roof, and much less exposure hazard for the shotfirer.

Aside from charging and firing responsibilities the shotfirer or shotfiring crew necessarily must transport tools and supplies. This problem is considerably eased by some form of wheeled conveyance. A child's red wagon, as an example, is extremely useful for this purpose, especially in thin coal.

Roof Control

ROOF SUPPORT is required in coal mining for two reasons:

1. Protecting men—and facilities—from falls, crushes, bumps and other top, face and rib failures.

2. Keeping working places, including entries, open for the desired length of time, which may range from only hours in pocketing through a pillar with a continuous miner up to as much as 50 yr or more for entries and airways in especially long-lived properties.

Achievement of these two primary goals also means achievement of certain collateral objectives, including:

1. No interruption of haulage, travel and other operations. Obviously, a heavy fall on the main line can shut down a mine completely, aside from the cost of cleaning up and timbering or retimbering. Even with light falls there is a penalty which, if falls occur with some frequency, can total a considerable sum in the course of a year.

2. No blocking or partial blocking of service openings, such as airways and drainways.

Roof Action

Support varies with the objective, and also with the character of the material over the coal. For example, temporary protection against drawslate will require one type of support, with another type where both the drawslate and all the overlying material must be held, and still others for permanent openings on top or caved ground. Weathering as a result of changes in temperature and moisture content of the ventilating air may warrant sealing the top, which is "support" in another guise. And so on.

In no instance, however, is it contemplated that the support provided by the original coal bed be replaced by support that will keep the roof in its original place and state after all the coal to be mined is removed. Even "permanent" support means only support until mining is completed. Between the time the coal is first opened up and the final pillars are removed, therefore, a number of roof conditions and roof actions may be encountered—some at every mine and all at some mines. Among them are:

1. Falls of Immediate Top—These result, among other reasons, because the top material is inherently weak, such as, drawslate or clod; because of cracks and cleavage planes; because of the presence of kettlebottoms, slips and the like; because of weathering; and as a result of such mining operations as pillaring. Such falls constitute the majority of the "accidental" type, and are the ones causing most of the injuries and fatalities, most of the operating interruptions, and most of the cleanup expense. The possibility of such falls is the major reason for emphasis on ample timber installed according to a fixed plan, and on the use of safety posts, jacks and bars in the face working area.

One question with thin, relatively weak roof layers over the coal is: "When to take down and when to leave?" Sometimes the material is so weak and crumbly that the question becomes academic, since there is no practicable way of keeping it up. Roof-bolting with channels, bars and short headers or capboards has made it possible at times to support top that otherwise could not be handled and which, when thick enough, rendered mining doubtful or impossible because of cost, hazard or both.

Depending on coal price, seam thickness and volume to be handled, a certain thickness of top material can be taken with the coal in room and pillar work. However, when this thickness reaches 6 in or more, the chances of economical production are considerably reduced if not completely eliminated. The rule, therefore, is to hold top material in working places, especially since support commonly is necessary for other purposes. There are exceptions, of course, to meet special conditions. In permanent or semi-permanent openings, the answer is "Yes and no." One of the conditions, for example, which might lead to a decision to take top, is a weak or crumbly drawslate over which is a good slate or sandstone. To save lagging of the slate, cleanup later on or both, the top would be taken to the hard material in the process of installing permanent support.

2. Rib and Face Falls—An alternative form is sloughing, which may be defined as minor face and rib falls, with spalling a minor form of sloughing. Rib and face falls also are of the type classed as accidental. Under certain conditions—thick, pitching coal, for example—such falls represent a real hazard. Sprags against the face and posts with plank stringers or lagging along the ribs are among the safeguards.

3. Squeezing—In its commonest form, squeezing is the slow increase in weight on pillars or solid coal eventually resulting in such things as crushing of the coal, heaving of the bottom and the driving of pillars into soft floor or top. The cause normally is leaving pillars or other support which, after considerable area is opened up, proves to be inadequate, permitting the top to settle gradually with transfer of the weight to active places and solid coal. Most old-timers maintained that once a real squeeze started nothing would stop it until settlement and readjustment were complete.

An alternative to squeezing is sudden collapse, which may also occur after a period of squeezing. Like squeezing, sudden collapse is rather infrequent, but it does occur, especially where thin room pillars customarily are left, or where a strong member in the top results in the creation of a large open area without a fall in pillaring. One of the effects and one of the several hazards is the ensuing air blast which, in the magnitude sometimes attained, in addition to wrecking doors, stoppings and other structures, can knock cars off the track and throw people around sufficiently hard to cause severe injury or death. Preventives include ample pillar area and careful attention to getting initial breaks quickly.

4. Bursts or Bumps—These are the sudden, explosion-like failures of coal as a result of internal stress caused by weight. In most instances, conditions conducive to bumping include heavy cover with strong members and especially a strong member close to the coal; a point at which weight and stress tend to concentrate, as the apex of two converging pillar lines, a barrier pillar sticking out into the gob, and so on; and a strong floor. As noted elsewhere in this "Deep-Mining Guidebook," drilling and augering can be used to trigger bumps or unload stress before it becomes too great. The

THREE-PIECE SET is the old-reliable in permanent support with timbers. Treatment materially lengthens life.

HITCH TIMBERING eliminates legs. Lagging and cribbing protect top in this pin-and-stringer version.

Four Basic Permanent-Support Systems

STEEL LINING protects opening in soft ground. Other linings include concrete and sand-cement.

YIELDING ARCH for unstable ground can be made of steel, as shown, or of concrete sections.

basic line of defense, however, is adjustment of the mining plan to prevent stress buildup. Some suggestions are:

Get all the coal. Clean out timber also, since leaving props and cribs can help set up conditions conducive to bumps.

Mine pillars as fast as possible—at an even rate. The quicker pillars can be mined, the shorter the period of time for stress development.

Orient the pillar line with the natural fracture system of the roof to promote caving in the gob, thus preventing the formation of long roof spans. If long spans cannot be avoided, some means of support should be provided to prevent breaking. Cribs are an example.

Keep development out of abutment or stress areas next to pillar lines and gobs, and develop for new pillars away from rather than toward such areas.

Adjust mining to prevent the formation of points on pillar lines. Keep lines even—no projections into gob area.

Keep pillars as large as possible to reduce the chance of failure under stress. Uniform size and shape keeps stress even and prevents concentration on certain large or odd-shaped pillars.

Mine individual pillars open-end where possible and keep lifts fairly narrow.

5. Intentional Caving—Since caving relieves the remaining coal of weight—at least in substantial measure—and thus eases the job of mining and support where pillars are removed, much of the roof action in mining is intentionally induced. A common goal is a fall each time a lift is taken off a pillar, and this goal is fairly easily reached under conditions ordinarily encountered. Thus, support is provided to (a) break the top at the edge of the new lift and (b), with other support as necessary, to hold the top within the lift and keep it open.

Roof action in intentional caving commonly takes place in two to three stages. The first, or initial, break snaps the roof off at the breaker line. The cave commonly extends 25 to 50 ft up into the main roof. This is followed by a secondary cave spanning several of the initial caves, and extending up to, say, 150 to 300 ft. If this is not sufficient to take the action to the surface, a third cave and general settlement normally occurs. Usually it is of sufficient magnitude to reach the surface unless the cover is exceptionally thick. Where subsidence is limited by packwalls or some other form of support, the initial strata may be cracked as a result of bending in the slow subsidence but falls of the type encountered in complete caving are relatively infrequent. Also, roof action, aside from a gradual and limited subsidence, seldom extends to the surface.

Timbering

Types of support in the "timber" classification range all the way from roof jacks at the face to steel, concrete and brick linings in permanent openings. Between these limits, timber includes posts, legs and bars of wood, steel and aluminum; yielding arches and rings of reinforced concrete and steel; concrete, brick and masonry columns, piers and abutments; such supplementary items as wedges, capboards, headers and lagging; and coal itself. Other forms of support, in addition to timbering, are bolting, and coating and sealing, discussed later in this section.

PERMANENT TIMBERING

The goal in permanent timbering should be "permanence," meaning that life of the support, within economic limits, should match the expected life of the opening. This is not an absolute rule, however. In ground where movement can be expected for some time until the measures stabilize (longwalling, or driving gangways through previously worked ground, for example, it may be desirable to make the initial timbering job a temporary one, replacing it with final permanent timber when things have settled down and no more disturbance can be expected.

As an example of "permanence" which is not permanent, consider the case of untreated wood with a life of around 3 yr in a haulage heading with a life of 10 yr. Since treated wood normally will last at least 10 yr, it could be considered "permanent," whereas with untreated wood the initial installation would have to be replaced at least once and probably twice, with each replacement normally more expensive than the original. The moral is that within limits it is better to spend more at the start for permanence, not only to eliminate replacement, and also production stoppages as a result of falls, but also to keep routine maintenance as low as possible. When timber is installed so that it doesn't rot, fail under load, or permit sloughing and spalling, as examples, conditions are most favorable for keeping maintenance to the bare minimum.

Conversely, of course, timber or support life can be excessive—and thus excessively costly—in relation to life of opening. As an extreme example, it would be wasting money to line a 10-yr-life opening with reinforced concrete, though a sand-cement mixture an inch thick on wire might well be the best type for the particular application.

Lining—Support by complete lining is limited to rather special situations in mining. These include: soft sections of top near the outcrop in a permanent drift opening, or other soft or broken areas, as under stream valleys; and permanent long-lived openings on shaft or slope bottoms. Reinforced concrete is the old reliable in heavy-duty linings, and also provides complete sealing. Sealing with some support is provided by sprayed-on sand-cement mixtures, though support is only nominal when, say, they are only ¼ to ½ in thick. When applied over wire and in thicknesses up to 1 or 2 in. they provide some holding power in addition to sealing. Steel liner plates also provide sealing with a considerable degree of support, and are low in cost and easy to install, using a concrete footwall as a starting point.

Piers and Abutments—Supports of these types usually are found at pillar points where openings fork, and at other places where considerable resistance to roof movement is necessary. They may be built of concrete, with or without reinforcement, concrete or cinder blocks, brick or masonry.

Yielding Arches and Rings—Where weight is substantial, the top is badly broken, and there is a possibility of movement of the ground in which the opening is made, yielding arches or rings may be installed. Some types employ concrete blocks put together on the keystone arch principle. Of the steel types, the latest in the U. S. (*Coal Age*, April, 1954, p 92) is the full-round with joints that slip and thus permit diameter to decrease without deformation until equilibrium is re-established.

Three-Piece Sets—Probably the widest used of all forms of permanent timbering, the three-piece set—a crossbar supported on legs at each end—may range from a simple affair put together at the site up to a preframed and largely standardized set designed for heavy duty. Wood is the commonest material. As noted previously, it should be treated where life of opening is expected to exceed about 3 yr. The set also may be made of steel or may consist of wood legs and a steel bar where extra stiffness and resistance to bending are desired. If

CRITICAL ZONE is face area where most falls and injuries occur. Timbering should be systematic, with safety the first consideration.

MOBILE TIMBERING MACHINES cut cost of adequate face support and at the same time facilitate adherence to standard plan.

steel legs are used, they should be set on concrete piers or low footwalls for maximum stability, especially in longer-lived places.

Wood is easy to obtain and work, and the three-piece set is both flexible and adaptable. Also, it supplies the required degree of support except under exceptional conditions, in which case special concrete or timber arches are about the only answers. Legs, however, reduce clearance and can be knocked out to cause, in many instances, severe falls, aside from the fact that they themselves represent an expense.

Two-piece sets are an alternative to three-piece under certain conditions—for example in a water-level gangway in pitching coal where one end of the bar is hitched into coal or rock and the other on a leg.

Hitch Timbering—To eliminate the leg and its hazards, bars may be installed in hitches either cut or drilled in the rib. Hitch holes may be provided for each individual bar. As an alternative, holes may be drilled some distance apart to accommodate pins. Steel bars are then laid on these pins and the regular bars are placed on these stringers. Properly done, hitch timbering is permanent, especially if treated wood or steel bars are employed, and cost of installation (labor and materials) is much less than installation of a regular three-piece set. Routine maintenance and cleanup are cut to a minimum.

Lagging — Spalling of top and sloughing of ribs are the reasons for the installation of lagging which may be small natural round timber or sawed material. In long-lived openings, lagging, like main timbers, should be treated. Lagging also provides some support, but its major function is holding loose material in place, keeping it off the track and reducing cleanup expense. Special forms of lagging include precast reinforced-concrete sections designed to be laid between H-beam crossbars (*Coal Age*, April, 1949, p 87).

Single Posts—These have a wide use in permanent support, especially in openings where the spacing can be cut down, as in airways, manways and belt headings, or where the roof needs some support but a span of, say, car width can be tolerated. Short headers may be used to increase holding spread in tender top. As with bars and lagging, permanent posts, together with wedges and headers, should be treated.

Coal—Coal itself is widely used as a means of protecting and supporting top, though the support is chancy and not too great from the standpoint of resistance to weight. Sealing of the regular top is perhaps coal's major contribution, and for real support it normally should be supplemented by conventional timbering or bolting. Where this is done, coal can serve very well to prevent spalling, sloughing and gradual disintegration of the immediate top.

TEMPORARY TIMBERING

Temporary support naturally finds its widest application in the active working areas, including the working face, the room and the room entries. The major objectives are perhaps three:

1. **Protecting men.** The average dimensions of roof falls resulting in fatalities is given by the Bureau of

Mines as: length, 13 ft; width, 9 ft; thickness, 1½ ft. The majority of these falls (75%) occur in the face area inby the last permanent support, and 93%, says the bureau, are a result of human failure, meaning in turn primarily failure to install proper support.

2. Keeping workings open. The aim here is to preserve access to the face area from which production comes, meaning the rooms and room entries.

3. Holding top during pillar removal. Here, the support should have sufficient strength not only to hold the place open as long as necessary, but also to break the top at the desired point and thus help initiate the caving process.

Standard Plans—The key factor in temporary support, particularly in the critical area within 25 ft of the face, is a plan for minimum support rigidly adhered to and supplemented with additional support where there is any doubt that the minimum is insufficient. The fact that nearly a third of the roof-fall fatalities occur where a timbering plan has been established is reason for emphasizing the need for supplementary support.

Face-Area Support—If coal is to be produced, both machines and men must work in the face area, which also means that timbering must be planned to permit reasonably efficient mining while at the same time providing maximum protection against all the hazards of newly exposed top whose condition is largely unknown. Among the specific hazards are slips, clay veins, kettle-bottoms and the like, aside from general weakness, as in the case of certain drawslates, clods and the like. Also, unless caught, certain roof members will separate and sag, thus requiring more attention than if they had been secured immediately. Swelling or disintegration as a result of moisture are additional difficulties that may crop up in face support.

The first line of defense in face support is the safety post or safety jack. The latter has the advantage of being easier to install, as well as to move to permit machines to pass. Interference is relatively little with hand-loaded conveyors but increases progressively and mining moves toward mobile machines. The crossbar is one logical answer to keeping support close to the face while at the same time keeping down interference. Where the coal is low, crossbarring, especially if weight sags the bars, may result in too-little clearance for mobile equipment. This has resulted, in some mines with poorer top, in conveyors being chosen instead of loaders.

HAND-PUMPED HYDRAULIC LIFTER here eases job of replacing heavy threepiece set. Truck mounting facilitates movement.

TIMBER RECOVERY is facilitated by power winches mounted on crawlers, as in this unit, or built onto gathering locomotives.

Face support plans are almost infinite in variations but the general routine is to extend posts or crossbars to the face immediately after loading to protect the cutters, drillers and others engaged in preparing the next fall. Roof jacks may be used to protect machine operators specifically and saddle jacks may be employed under bars to permit movement for cutting with shortwalls. Then, after shooting the top may be caught by safety posts or jacks as soon as an appreciable area is exposed by loading. Thus, support is provided whenever there is an opportunity for installing it.

Protection for loader and miner operators, who are relatively far back from the face, commonly is provided

by crossbars spotted over the machine and either left in place or moved up. Use of bars of course is dependent upon sufficient height for clearance. Handling bars in the face zone, particularly where they are moved ahead each time a cut is made, is somewhat of a problem, particularly, if metal or heavy wood is needed for strength over the necessary open spans. As a result, a number of operators employ aluminum H-sections which are both stiff and light for high holding power and ease of handling. One mine, as an example, keeps two such bars in each place moving them ahead when each cut is completed.

Pillar Support—In addition to the regular protection of men, machines and working places, support in pillar sections usually functions as a top-breaker also. Coal itself is a form of support, either as stumps, thin straight fenders, or sawtoothed fenders made by gripping or cutting out on the gob side, as examples. Frequently, a part or all of this coal may be recovered, and even if it is not, it represents a support cost considerably less than the conventional timbers or cribs. Artificial support, as in solid work, consists of jacks, posts and bars used much the same way, plus cribs and breaker timbers, both the latter primarily to break the top and at the same time protect rooms and pillar places against the riding over of caves.

Heavy weight or other special conditions may warrant special measures in roof support during pillaring operations. At one mine, as an example, the first step in mining a block open-ended is to crib it on the two sides next to the gob, supplementing this with similar cribs on a number of neighboring blocks. Overburden at this operation ranges up to 1,500 ft in thickness and the immediate top is 40 to 80 ft of sandstone. At another property, the machine operator is protected in recovery of the final corner stump at the intersection of the pillar split and room by erecting cribs on each side of the space in which the machine advances in mining the stump.

Room and Room-Entry Support—Depending upon equipment and mining plan, "permanent" room and room-entry timbering starts at from one cut up to 25 ft back of the face. Usual types are posts with or without capboards or short headers, and three-piece bar-and-leg sets. With topcutting in thick coal, legs may be eliminated by gripping out with the bar to form slots into which the bars may be slid.

TIMBER ECONOMICS

If a place makes 25 tons and a post costs 75c to buy and the same to install, the cost is 6c per ton. Therefore, particularly where no recovery is contemplated, support methods, materials requirements and possible recovery should receive intensive study. Elimination of fatalities and injuries, and the promotion of efficient mining are, of course, the overriding goals and should not be jeopardized by stinginess in timbering. However, since even saving one post per cut amounts to considerable money per ton, a change in the posting pattern—perhaps by staggering, as an example—can achieve this saving and still provide the requisite support and protection. Where bars and other more-expensive items are involved, the desirability of close study and economy becomes even greater.

Timber Installation—Even though it may prove impracticable to reduce the number of timbers set—particularly crossbars—substantial economies in setting cost can be achieved by timbering machines, now available in a number of types with both rail and rubber-tired mountings. The first commercial design for a timbering machine was developed nearly 10 yr ago, and one of the first installations saved its user 12c per ton in reduced labor for timbering and higher tons per loading-machine unit.

In addition to mobile units, small hand-operated lifts have been developed for replacement and installation of crossbars in entries and gangways. They are designed for mounting on one end of a flat-bed car or truck.

Even without special machines, the timber crew's work can be lightened and its capacity increased by the use of timber jacks to take the manual labor out of raising crossbars. And in thick coal, where universal cutters are employed, the cutter bar may be pressed into service to lift bars into place.

Salvage—The practicability of recovering posts, bars and other timbering material depends on (1) whether it is safe, (2) whether, as with the customary untreated material, decay has left it with little useful life, and (3) the cost of recovery. If these and other questions can be answered affirmatively, recovery can then proceed, but only on the basis that adequate temporary support be installed before the post or bar is removed, or that removal be done from a remote and safe point.

Removal sometimes is synchronized with making falls in pillar mining. Supports may be pulled one by one from a remote point using the old-reliable hand-operated post-puller, or "sylvester." Greater economy and the ultimate in safety is achieved by pulling supports in groups with a power winch, wire line, and chain or chains. Some coal companies, for example, have mounted motor-driven winches on old locomotives to convert them into mechanized pullers, while others have put the winches on crawler-type shortwall trucks. Even with the best of equipment, recovery is only a fraction of the total timber installed, though a sizable one in many instances, with consequent over-all reduction in cost of posts and bars. In some instances, posts and bars have been reclaimed and re-used as many as five times.

Roof-Bolting

By the end of 1955, probably more than one-third of the bituminous coal produced in the U. S. will be mined with roof-bolts. This reflects, among others, the following advantages:

1. Better support and consequently fewer injuries and fatalities from falls. According to Bureau of Mines, it is 5½ times safer to work under bolted top, compared to timbered. One reason is that bolting lends itself better to the development of definite patterns, and to closer adherence to the patterns after development. Clearance—either side or top—is not reduced in bolting, and there are no timbers to be knocked out.

2. Higher output per man and machine as a result of more working room and no interference.

3. Less bulk in support material to be stored, handled and transported.

4. Better coal cleanup. In some instances, loss of coal behind timbers is as much as 5% of the total or more.

5. Higher extraction as a result of good top conditions and fewer or no falls throughout life of place.

In some instances, all these advantages—or many of them—have been secured with an actual reduction in support cost as a result of bolting. Normally, however, bolting cost, everything considered, is slightly higher than conventional timbering, but is warranted because of the advantages enumerated previously, as well as others.

Bolts broke into coal mining as a means of roof support in solid work. They then moved into support in pillaring and also are used to prevent

heaving of bottom and the sloughing or caving of coal or rock ribs in shafts, slopes and entries. In addition to the usual steel bolt, wood pins are being used to a limited extent for the same purposes, i. e.: holding top and stabilizing ribs. Bolts, however, are not a universal cureall for roof troubles, and conventional timber may be better from all angles under certain conditions.

BOLT TYPES

Roof bolts normally function by pinning a number of weak members together to form a strong beam. A somewhat rare function is hanging loose lower members to a strong upper member. In beam-building particularly, the desired result is attained by anchoring the bolt and then screwing a bearing plate up against the top. This, it will be recognized, puts the bolt in tension and makes the beam-building action possible. Unless the bolt is tensioned, there is no beam action, and unless tension can be achieved, meaning that an anchor stratum must be found, other means of support normally must be employed.

Major bolt types are the "split-rod-and-wedge" and the "expansion-shell." Special versions of each include the sectional type for use in very thin seams where deep anchorages are necessary.

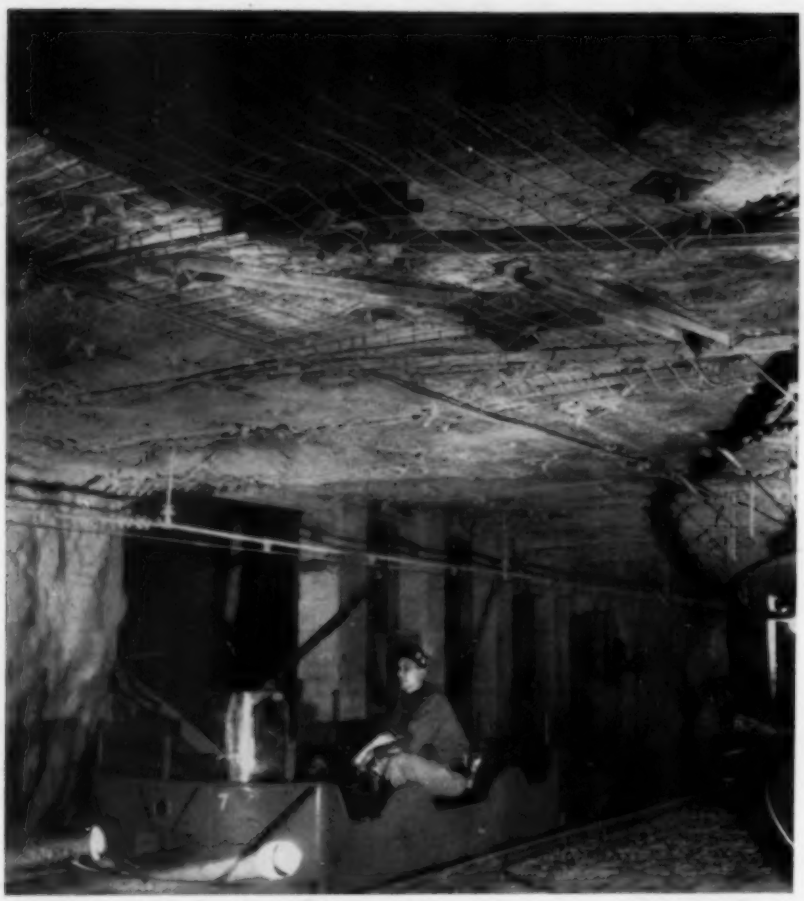
Split-Rod-and-Wedge—Properly installed in rock of the right type, load-carrying characteristics are excellent. It is easy to install and is not weakened in the installation process. However, it requires compressed air for driving and thus may require the purchase of compressor equipment. The extra step of driving the bolt into the wedge increases installation time approximately 20%, and cost of materials usually is higher. It loses its holding power more readily in the softer, semiplastic rocks and protruding bolt ends are a hazard, though they may be clipped with special bolt cutters.

Expansion-Shell—Requires no driving to anchor, is better suited to softer semiplastic rocks, is normally cheaper—about 25%—and can be installed in shorter time. However, it is more difficult to tension properly, and maintenance of tension is difficult in soft material.

Usual bolt size today is ¾ in. Tightening to a torque of approximately 150 ft-lb will develop a tension of 8,000 to 10,000 lb, or approximately, 75 to 80% of the yield point of the usual mild steel in pure tension. With

ROOF-BOLTING with check timbers provides permanent support for airway roof with a minimum of obstruction of air flow.

CONCURRENT BOLTING with continuous mining employs short wood headers. Other plans are based on planks and wood bars.



SPECIAL BOLTING PLANS include this example of use of short channels and wire mesh to protect an intersection alongside a crosscut.

BOLT RECOVERY usually employs hand tools. Safety posting is essential, and men should work in pairs for mutual protection.

the development of high-strength bolts, the use of ⅝-in units is expected to become general, since the cost is 10 to 15% less. Safety authorities, however, warn against tensioning past the yield point, and also against any increase in strength which would render the bolts brittle.

BOLTING PATTERNS

As with timbering, the pattern with bolting must be adjusted not only to conditions at each mine but also to variations within each mine. And since an individual bolt in place seldom costs less than $2, including equipment maintenance and depreciation, etc., saving even one per cut, provided safety is not jeopardized, is a worthwhile economy. By the same token, auxiliary forms of support should be omitted unless they contribute to holding power and safety.

Auxiliaries, however, are a necessity under certain conditions. For example, if the roof is tender or contains slips, cleavage cracks, ketlebottoms, and the like, wood headers or crossbars on the bolts, including steel channels or ties (sometimes with wire mesh) in permanent openings, are as much in order as if posts or legs were being set. Mixed bolt and timber plans, as a matter of fact are fairly common. For example, though bolting can result in compacting the roof members, it may not provide a beam with all the strength necessary, especially over the longer spans. However, it does provide a great deal of the required holding power and makes the conventional timbering less complicated and costly, in turn reducing the overall cost of the entire support job. Also, since bolts do not show subsidence, posts may be installed in pillar places as indicators of weight and convergence, aside from providing backup support in final recovery operations.

Mixed patterns also include, as an example, installing crossbars in pillar splits with legs on the gob side and bolts on the solid side. Bolting provides more room in the split for working, while the legs become part of several breaker posts set under each bar to hold the top during mining of the next split.

Where bolts are used alone, a check of published descriptions apparently indicates that the majority are placed on 4-ft centers, compared to 4 to 5 ft with crossbars and individual posts. Special patterns for long spans or weak top include the "star" (a bolt in the center of a four-square pattern). Also, under some conditions, making part of the bolts—say every other one—longer may be helpful.

BOLT INSTALLATION

Split-rod-and-wedge bolts require a percussion tool for installation, which in turn requires compressed air. Since bolts of this type were the first to be developed, air was the first bolting medium, being used both for drilling and driving.

Air still is the preferred medium for drilling the hard rocks encountered in mine roofs, even though electric rotary drills have been taking on harder and harder material. Portable compressors are widely used, though central stationary units have their advocates, who state that the advantages include plenty of air at rated pressure, lower maintenance and less trouble with dirt and water in air lines. Portables may be mounted on rubber or crawlers, or may be carried in shuttle cars. They may be sized to operate one or two stopers, but in any event they should be capable of supplying drilling needs without drop below rated pressure.

Development of the expansion-shell bolt put the electric drill into the bolting business and now a wide variety of units are available. At the same time, rotary drills have been put into harder and harder material, though they still cannot cope too well with extremely-hard types. Experience has indicated, however, that reducing rotational speed and building pressure up to a maximum results in better footage in hard cutting. Sharp bits also speed penetration, and reduce the other ill effects of a lower rate of penetration in hard material, i. e.: faster bit wear, shorter bit life and higher drilling cost. And where bithead design is such that high penetration rates are possible, higher drilling pressures yield better results.

Of the two main methods of suppressing dust—water during drilling and dry collection—the latter is forging ahead because of the inherently greater complications of water. The simplest form of dry collector consists of a flexible collar held against the roof to collect the cuttings and drop them into a bag or onto the floor. More positive means of collection and disposal are provided by vacuum units operating through collars around the drills or, in the latest, by pulling the cuttings through hollow bits and drill steel.

Concurrent Bolting—Continuous miners, since they stay in one place, have presented some problems in attaining the benefits of bolting. Until recently bolting normally required stopping the miner at least for drilling. A long step toward solution of the problem resulted from the mounting of two hydraulic drilling and bolting units on the miner—one on each side immediately back of the timber jacks (*Coal Age*, April, 1954, p 102). With these units, two men drill two 5-ft holes and place two ¾-in expansion-shell bolts with wood headers in the time it takes the miner to cut across the face. As a result, the available working time for the miner was increased 15%. Since the bolters can be swung 30 deg, the bolts in the two rows on each side of the place can be staggered for greater coverage.

Bolting Dos and Donts—Check hole size and avoid overdrilling as a result of worn bits, whip and the like, especially in soft material where maximum holding power is a necessity. Diameter gages are a convenient means of making such checks.

Where expansion-shell units are employed, check plug and shell position periodically by removing sample bolts, to insure that bolts are properly anchored.

Use caution with wood headers to make sure that bolt tension is preserved. Wood can dry out, yield under pressure and otherwise change characteristics with consequent loss of tension. Never install a wood header or crossbar with nut alone. Always use steel bearing plate.

Check tightening torque carefully. In hard material, up to 200 ft-lb may be employed. In soft material, under 150 ft-lb may be advantageous. Bolt-tightening equipment should be checked with a torque wrench.

Check tension on bolts in key areas occasionally, since relaxation for a number of reasons may have occurred. Retightening may restore tension or replacement may be desirable.

For a fuller discussion of questions involved in bolt installation, see *Coal Age*, June, 1954, p 98.

Bolt Recovery—Since, as with timbering, except on pillar lines, it is estimated that not more than one bolt in 10 is ever called upon to actually support top material, salvage almost automatically becomes a matter for consideration, since whether the bolt is holding top is a major factor in determining whether recovery is possible. Even if most of the bolts were supporting top, salvage would still be possible by installing protective support, but the hazards are substantially greater and the savings possibilities correspondingly less.

Recovery operations so far are limited almost entirely to the expansion-shell type of bolt. Under favorable conditions, recovery cost is ¼ to ⅓ the cost of a new unit, including expenditures for new shells and nuts to go with bolts and plates that have been salvaged. Hand salvage is the rule, and a basic principle is setting roof jacks or safety posts before any attempt is made to remove a bolt. A second principle is at least two men to a salvage crew, since two heads can be better than one in guarding against hazards, and the second man, in case of trouble, can, in many instances, prevent an accident from turning into an injury or fatality. Experience so far indicates that a two-man crew can recover 200 to 300 assemblies in a shift.

Coating And Sealing

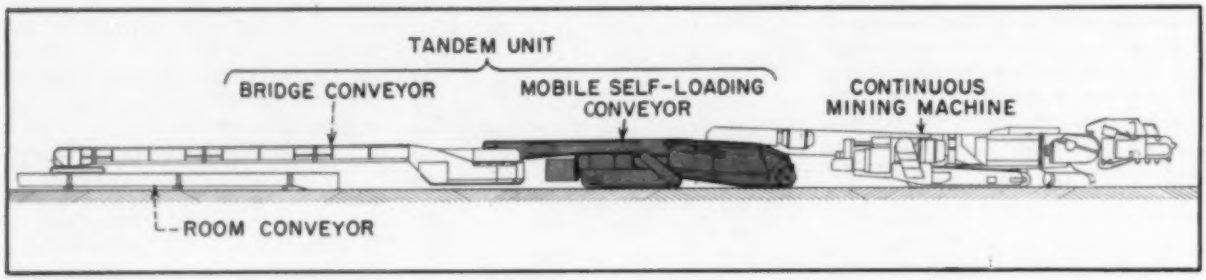
The susceptibility of certain types of roof to changes in moisture and temperature is so pronounced that a number of deep mines in the past have installed elaborate conditioning units to insure uniform humidity and temperature. More recently, even though the idea is old, a number of operators have turned to coating and sealing to prevent roof and rib deterioration as a result of these influences.

Coating and sealing products include vinyl compounds, coal-tar products and mastic-type materials—all sprayable with or without heating, usually because they are dissolved in a volatile compound which evaporates after application. Because solvents normally are flammable or explosive, or both, care must be taken in application. Also, care must be exercised to see that after application the material will at least not propagate fire even if ignition cannot be prevented. A number of products now on the market meet this standard.

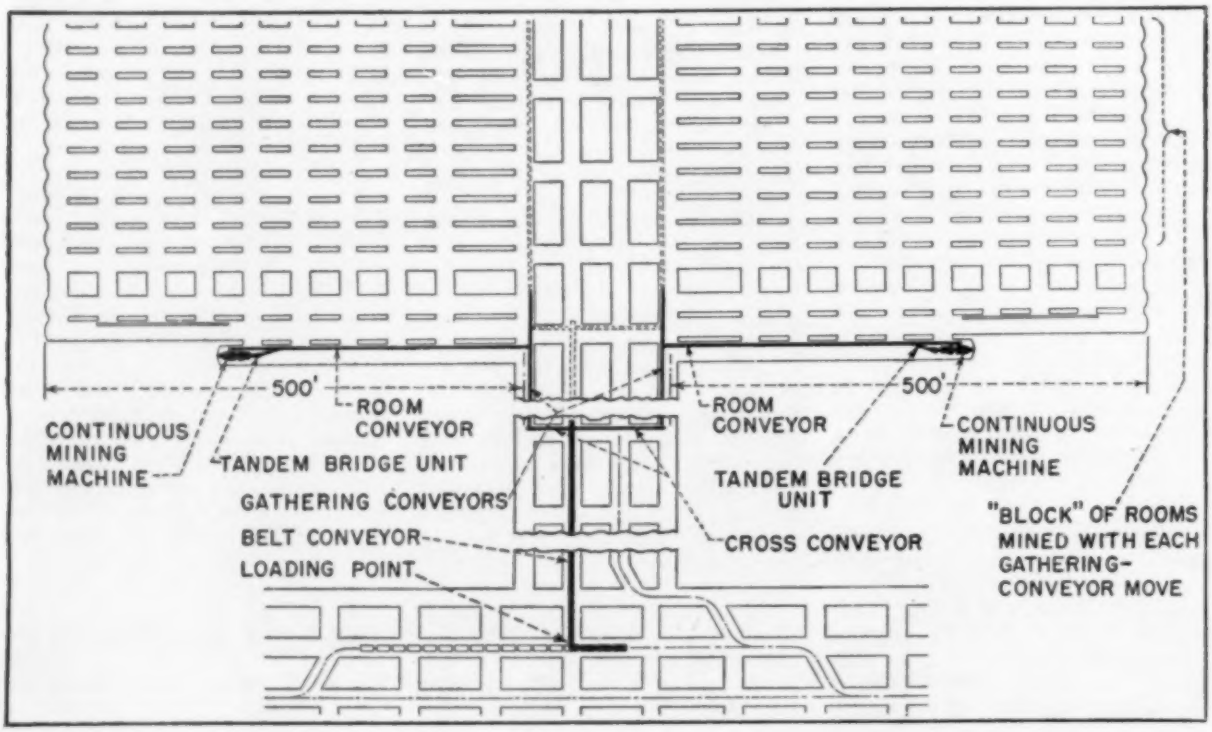
Careful scaling and dryness are major prerequisites to good sealing. Though it provides no support, sealing has cleaned up some very-costly roof and rib disintegration situations at a number of mines where conventional timbering failed to do the job. Cost varies from 15c to 20c per square foot minimum at most operations, including scaling and other preparations. Usual practice is to seal the top and carry the coating 6 or 12 in down each rib for insurance. At some mines, all the coal ribs are sealed to prevent sloughing. One of the incidental benefits is a smoother surface, which helps ventilation. With an asphalt-base compound, one group of mines has blown on portland cement at regular intervals, which picks up moisture and hardens to an enamel-like finish, further strengthening the basic coating.

EXTENSIBLE BELT with bridge conveyor for connection to continuous miner permits driving places up to 1,000 ft deep. The belt can be lengthened or shortened 50 ft in less than 5 min.

Three New Units for Continuous Haulage



TANDEM BRIDGE PLAN includes mobile self-loading conveyor (above) behind continuous miner for greater flexibility. Advantages include deeper places. Plan below shows mining with multiple units and single loading point.



ARTICULATED CONVEYOR prepares to follow a remotely controlled continuous miner into opening in pit highwall. Each unit is self-propelled. An alternative in remote mining is a series of wheeled conveyors pulled by the miner.

Transportation

THE FUNCTION of transportation is to move coal from the face as fast as the loader can load it or the miner can mine it, and keep it moving to the preparation plant on the surface without interrupting loading or mining. This means that the transportation system should always be in place and ready to carry coal anytime loading is in progress. Furthermore, the system should have capacity to handle any peak the loader or miner is capable of reaching. Finally, the system should operate with a minimum of manpower and maintenance.

Face Haulage

Although mine cars have moved into a minority status in serving face units, some of the lessons learned in attaining maximum efficiency with them apply with equal force to their successors. One lesson is use of the biggest car possible to cut down the number of changes and thus increase loading time. A second is a haulage layout providing at the best a changing point no farther back than the next crosscut, and at the worst no farther than 150 to 175 ft back. One contribution to the short change with cars was the development of prefabricated track layouts, which practically guaranteed a changing point at every crosscut.

Track condition has a real and substantial effect on car-service efficiency, not only in rooms where loading directly to cars is the practice but also even in panel-entry operation with shuttle-car or conveyor haulage in rooms. Heavy rail—up to 50- to 60-lb—is one assurance of good track in panel entries, where 40 lb is about the lightest that can be tolerated with big cars and locomotives in keeping with such cars. Steel ties and prefabricated steel-tie turnouts naturally cut cost of installation and removal to a minimum. Throws on turnouts, among other things, considerably reduce the development of situations leading to derailments.

SHUTTLE CARS

As with mine cars, the bigger the shuttle car, within limits set by seam and other conditions, the fewer the changes and consequently the fewer the interruptions in mining and loading at the face. Also, as with mine cars, the closer the changing point, assuming the usual two and sometimes three cars per unit, the higher the efficiency.

Surge Cars, Pickup Loaders—The relatively low capacity of the early continuous miners quickly brought out the fact that the intermittency of shuttle-car service, even with the best of setups, was a considerable handicap. Among the steps to offset this handicap is the establishment of storage or surge capacity between miner and shuttle car. The mine bottom is one form of storage, in turn bringing in the pickup loader. Even with the cost of the loader and operator, the increase in miner performance has been sufficient in many instances to show a handsome gain.

The surge car is a possibility under some circumstances but is not a cure-all. The car may be a standard shuttle car or a specially built unit. Whether to use a surge car can be determined only after a careful study. Among the factors that militate against their use is large shuttle cars and a short changing distance. Also, as miner capacity increases, the situation becomes more like machine loading, where the capacity of the face unit in tons per minute is so large that some delay might be tolerated, even though

it sets a dangerous precedent. If miner capacity is low, or if changing distance is long, a surge car of the right type can be a help.

Haulage Limits—The maximum length of shuttle-car haul is approximately 500 ft with two cars per face unit. The tendency, however, is to keep the maximum under 400 ft where possible because of excessive loss of miner or loader working time as room depths near their limit. This may be offset in part by introducing a third car, which, however, requires extra investment in equipment and labor, and very careful organization of the haulage system to prevent interference. However, some operators use the third car quite successfully.

The cable-reel limit can be stretched by anchoring the cable at the midpoint and backlashing on half the run. Some operators who have tried it recommend against the practice not only because the long hauls raise loader waiting time, but because backlash reeling is more difficult and is harder on cable, guides and reel. Therefore, usual practice is to anchor at the discharge point. Shock-absorber-type anchorages are great cable savers, incidentally.

Transfer to Mine Cars—In addition to rubber-tired and crawler mountings, shuttle cars now are available in four-wheel-drive-and-steer types; with right- and left-hand drives for greater convenience in operation and in anchoring and reeling cable; and with elevating discharges. The ability of the four-wheel-steer and crawler machines to negotiate 90-deg turns, incidentally, has been in part responsible for a swing away from angle development back to the old-reliable square systems. Dynamic braking is available where loads are consistently moved down substantial grades.

Unless the track is sunk, an elevator is necessary for transferring from standard shuttle cars to mine cars. Sinking is done at some mines, and normally where this is the practice an effort is made to have one station serve places in both sides of an entry. The same practice also is followed where the top must be shot to permit the use of elevators. To keep the shuttle-car haul down to the minimum, stations normally are established at intervals of 200 to 300 ft. And also to reduce top-shooting as much as possible, at least one operator has developed a low-type elevating unit mounted on a crawler-type mining machine truck (*Coal Age*, September, 1955, p 72). A high-speed conveyor is provided to eliminate slowing down or stopping shuttle-car discharge. In this instance, transfer stations are prepared by the development crews every 120 ft.

Making it possible for the shuttle car to discharge at maximum rate without stopping is, as noted, a major element in keeping an operation tuned up to maximum efficiency. If elevator capacity is low, a hopper should be provided—usually by sinking the boot into the bottom. Or the chain should be speeded up. Provision also should be made for changing mine cars without stopping the elevator or shuttle car. Making shuttle-car and mine-car capacity match is one method being used at new mines or where cars or shuttle cars are being replaced. This method is especially effective with elevating-discharge cars, but works well with any other type of transfer equipment.

Transfer to Belts—A number of mines apparently encounter little difficulty in side loading belts from shuttle cars, but a greater number limit belt loading to end-on only, with usually a special hopper or a hopper-tailpiece combination to start the coal on its way. Side loading, these operators contend, results in greater spillage and, because the coal comes on at 90 deg, is harder on belts. Where side loading is practiced, with the belt in the center of three headings, it is possible, by assigning a crosscut on each side to a shuttle car, to load at four points, provided the crosscuts are offset. Also, with two cars, one may be assigned to the end position and the other to a side position in the next crosscut down to keep them apart at all times. In end loading, with auxiliary hoppers, there is an opportunity to install a grizzly to pad the belt with fines before the lumps hit. To load belts, either side or end, a low ramp or an elevating-discharge car is necessary.

Unless belt speed and width are sufficient to move the coal as fast as the shuttle car can discharge, delays are bound to occur. To prevent these, and also to improve belt-loading conditions, a number of steps may be taken. One is to install a two-speed motor with automatic timing control to speed up the belt while the shuttle car is discharging and cut it back automatically afterward. Transfer conveyors capable of taking maximum shuttle-car discharge and at the same time designed to feed to the belt at the proper rate are used at a number of mines. They may be of the belt, chain or shaker type, with or without hopper and with or without two-speed controls.

Incidentally, where a number of elevators or conveyors discharge to a belt, it is possible to interlock to prevent simultaneous operation and overloading of the belt by the outby unit. One mine uses a skate wheel on a flat spring under the top run of the belt (*Coal Age*, May, 1951, p 83). When the belt is loaded, the spring is depressed to hold in a button locking out all elevators except the one in use. As soon as the belt clears, the button is released to permit another elevator to start automatically. Other suggestions are finger or paddle switches actuated by being struck by coal to prevent an elevator or a crossbelt from pouring coal onto an already loaded main belt.

Shuttle-Car Roads—Ruts, dust and mud are the major difficulties in building and maintaining shuttle-car roads. A good rut preventive used at many mines is to sling a section of light rail or angle crosswise underneath the cars and just clearing the bottom, using chain or wire rope. The constant scraping action tends to keep roads smooth and prevent the formation of ruts. In dry mines particularly, calcium chloride keeps down dust and also tends to help the tires roll out and compact the bottom into a good running surface. Filling of established ruts is a rather informal process as a rule. One operator, for example, recommends throwing in big chunks of coal and letting the tires work them down.

Where there is much mud, planking is the usual answer, normally with 2x8's or 2x12's on stringers of the same material under the tire tracks. Spaces of, say, 3 in between planks reduce the number necessary and also provide places in which to lay cables serving other machines that might use or cross the roadway.

Tire and Tire-Filling—Water filling of shuttle-car tires is now widely accepted, though some contend that water should not be used at shuttle-car speeds. Lately, the solid tire has challenged the pneumatic type. Advantages include longer life, higher shuttle-car travel speeds and no failures (*Coal Age*, May, 1955, p 95).

BATTERY TRACTORS

Rubber-tired trailers or trailer trains pulled by battery tractors are among the developments and modifications of the original shuttle-car idea. They were developed primarily to meet the problems of the small drift mines in coal under 36 to 40 in, with some in 24 in or less.

Before the train idea was evolved, a number of designs for a low-cost shuttle car for such operations had been developed (*Coal Age*, April, 1953, p 88; July, 1953, p 88; February, 1954, p 116; June, 1954, p

101). Built with automotive axles and certain other automotive parts, the earliest such units usually had a capacity of less than 1 ton and were designed for hand loading. The usual motive power was a single-phase repulsion-induction motor with automotive-type transmission. The trailing cable, up to 1,000 ft in length, was dragged behind the unit. In later models, capacity was increased to 3 tons to permit use behind loading machines, and DC power was employed. Also, tractors were developed for pulling bottom-dump trailers. In all instances, the units operate all the way from the face to the dump outside.

The battery tractor is used to pull up to 10 trailers (*Coal Age*, May, 1955, p 99). It acts like a gathering locomotive also functioning as a mainline haulage unit. Both three-wheeled and four-wheeled trailers with lift endgates are used, and after the tractor pulls the trip to the outside it usually backs the cars one by one to a gravity dump, though dumping is done by hand on occasion. Hauls up to ½ mi have been handled by equipment of this type.

CONVEYORS

Since the conveyor is designed for continuous operation it is logical to consider it for all phases of haulage, including in rooms. In addition, the conveyor can work in low seams without taking top or bottom. Therefore, it finds wide application in thin coal because of both continuity of operation and low height, particularly where hand loading is the practice. The advent of the duckbill, sawbill and similar heads also provided the further advantage of converting the shaker type into a loading machine as well as a transporting unit. And to reduce moving time and labor, at least one crawler-mounted conveyor head is now on the market.

Bridge Conveyors—Continuity of operation also made the conveyor an attractive possibility for use behind loading machines. However, capacity in a practicable-sized unit is relatively limited, and keeping the tail boom in proper position over the conveyor is a time-consuming chore. As a result, conveyors made little headway in serving loading machines until the advent of the bridge unit. By providing a continuous and continuously functioning connection between loader and room conveyor, and by relieving the operator of all but the responsibility for keeping the machine in coal, the bridge unit has resulted in major increases in tons per man at the face. A typical bridge-unit plan appears on p 10 of this issue.

Evolution of the bridge unit has included development of the tandem bridge shown in the illustrations at the start of this article. A full discussion of the use of the tandem bridge in continuous mining under a variety of conditions appears in *Coal Age*, February, 1954, p 92.

Articulated and Cascade Conveyors—Development of the continuous miner and accompanying emphasis on development of conveying mediums also has resulted in the design of articulated and cascade conveyors and conveyor systems. One version of the articulated conveyor developed for a boring-type miner consists of a series of interconnected belt conveyors on wheels, each with its own driving and propelling motors (*Coal Age*, January, 1954, p 64). It is capable of advancing up to 1,000 ft simply by propelling itself ahead as the miner proceeds. It requires, however, a place for storage of up to almost all its entire length when places are breaking away. This storage may be outside in the pit in working from the outcrop, or down the heading in driving rooms underground.

The cascade system is substantially similar, but has some differences. One is in the fact that the conveyors need not be coupled, though hitches are provided to permit the train to be pulled behind the boring unit in one remote mining system.

The Extensible Belt—Newest in the list of conveying-type equipment for face service is the extensible belt, which also makes use of a bridge conveyor to provide a continuous conveying route from the solid coal to the main line (*Coal Age*, June, 1954, p 88; October, 1954, p 96; July, 1955, p 50). It is designed to permit a miner to advance up to 1,000 ft, if desired, in one place without any operations other than adding stands and belt. Sections of belt and stands 100 ft long, permitting advances of 50 ft, usually are added in less than 5 min. Plans for taking pillars with extensible belts include the one shown on p 21 of this issue.

Trip Loading

The major objective in setting up trip-loading facilities is prevention of delays to face units. A second is conducting such loading with no men if possible, and with no more than one if not possible.

TRIP MOVERS

Various systems and units for moving trips past loading stations, whether they be ramps, elevators, belt discharges, or what have you, include the following among others now used:

1. Gravity—Possible but hazardous when the usual spragging practice is followed.

2. Gravity Retarding — Feasible with a rope and a brake drum with manually or motor-applied brake.

3. Operator-Controlled Locomotive—Fairly widely employed in the past and still employed in a number of mines. Ordinarily means an extra labor cost unless the same motorman pulls to sidetrack or outside in which case care must be taken to see that the trip-changing interval is not too great. Complete looping of track, discussed more fully later in this section, facilitates this trip-moving scheme. And where locomotives pull to the outside and heavy grades are encountered, a few operators put locomotives both in front and behind trips both with loop track and with conventional layouts.

4. Remotely Controlled Locomotive—Machine with brake set up as required, and with the controller on the first point, on separate section of wire which is energized to move locomotive and trip by switch operated by boomman or attendant.

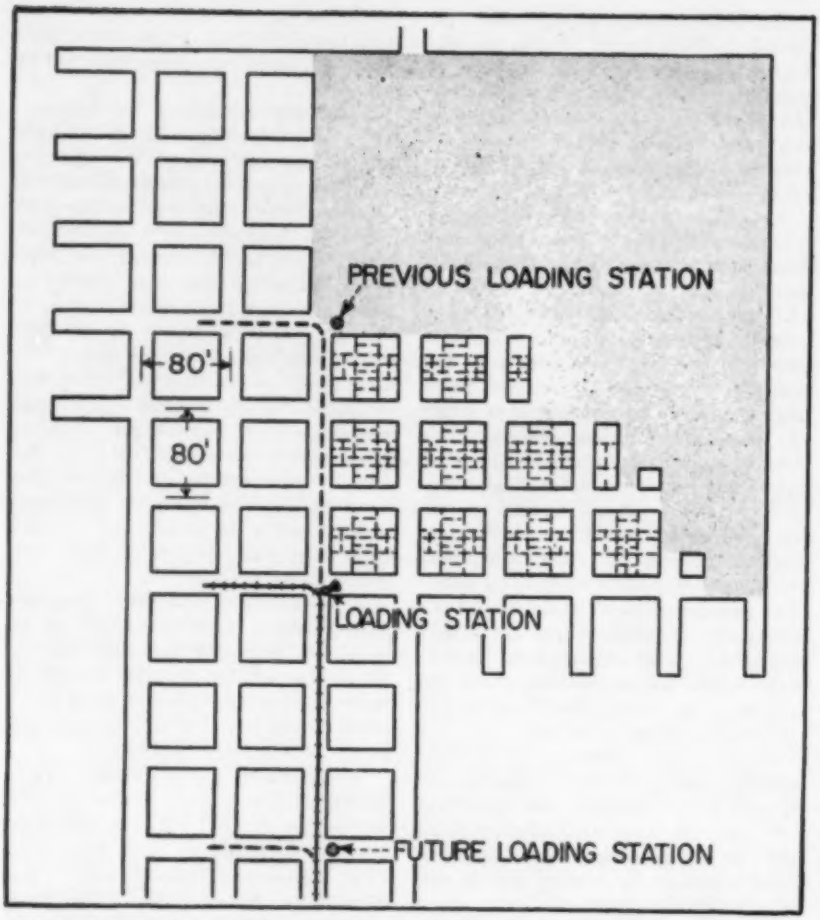
5. Remotely Controlled Trip-Spotting Hoist—Sometimes accompanied by smaller hoist to pull rope back for coupling to fresh trip.

6. Barney, Chain-Feeder and Ram-Type Between-the-Rails Spotters—Newest in the line of trip-moving equipment, these units are positive and accurate in operation and permit designing transfer stations for maximum efficiency in trip changing. The changing function can be preset or controlled by limit switches for precision and also for automatic performance if desired. Also such equipment lends itself to operation by shuttle-car drivers, and thus, even if not made automatic, requires no special attendants.

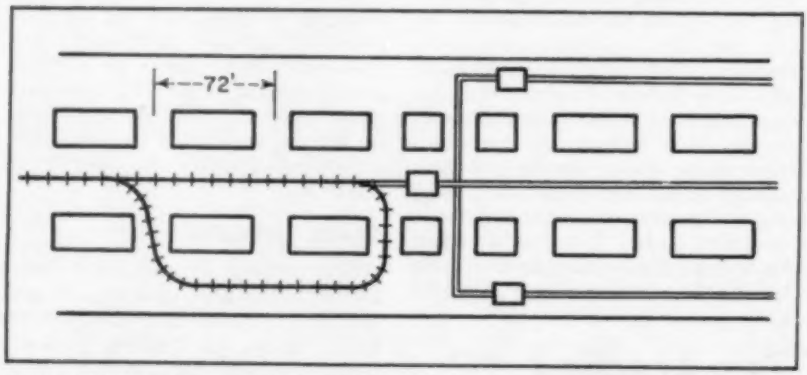
TRACK LAYOUTS

The simplest form of track layout for car or trip loading is the tail-track system. The track can merely be extended down the heading, or it can be turned right or left, as shown in an accompanying plan, or it may be turned right or left and then turned back U-fashion in an adjacent heading. The major disadvantage is that trips must come out the same way they go in, meaning increased loss of time unless the changing track is very close.

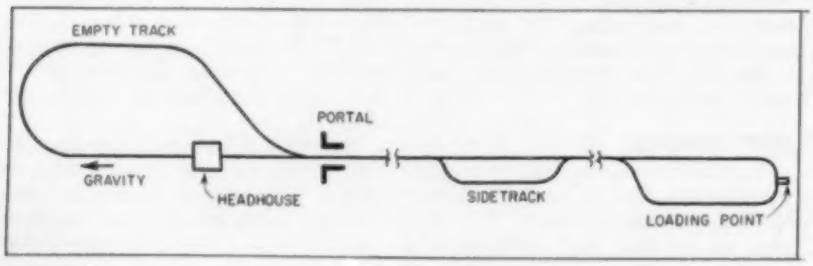
Sidetrack or loop-track systems provide access from both ends, and thus permit the quickest-possible trip changes, with no time loss at all if properly set up. The sidetrack—if that



SIMPLEST TRIP LOADING is tail-track system. Here, track is turned 90 deg through crosscut. Some mines turn it again to form a U track.



COMPLETE LOOP permits straight-through trip movement past conveyor loading point. A second loop outside (lower view) turns cars right-end-to.



is the system—may be in the same heading as the main track. More usually, however, it is in an adjacent heading, as indicated in the bridge-conveyor plan earlier in this section. Or the sidetrack may, in effect, be made continuous by tracking the second heading and installing chutes and crossovers at intervals, as indicated in the plan on p 16 of this issue. Double tracking represents some extra expense but does result in greater flexibility and more assurance of quickest-possible trip changes.

Full looping of track is becoming increasingly popular. In addition to two examples herewith, another plan, using a hoist for trip spotting, appears on p 10. It will be noted in these plans that a reverse loop is made outside to put the cars right-end-to. One advantage, particularly where the locomotive haul is uninterrupted from room section to tipple, is that there is no need for separate sidetracks to store empties or loads.

AUTOMATIC LOADING

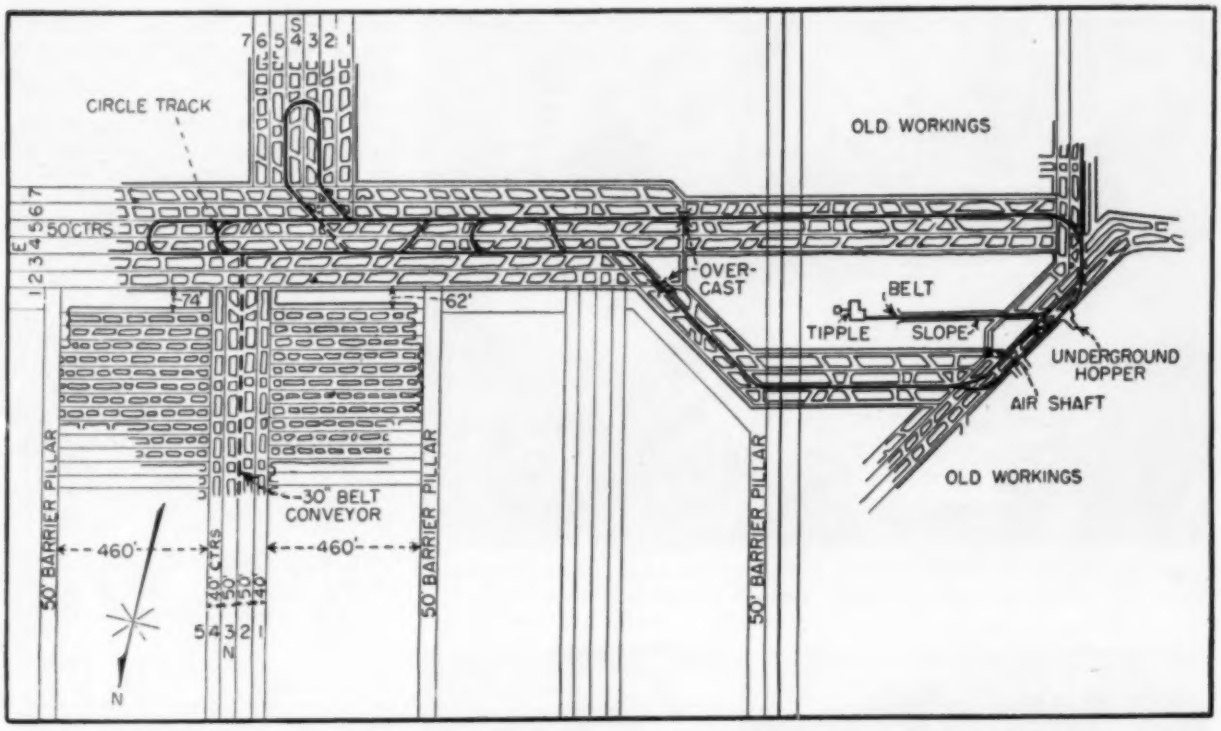
Complete loading of trips without any operators or attendants whatever already has been achieved in coal mining (*Coal Age*, August, 1953, p 99; March, 1955, p 66). The latest underground station (*Coal Age*, March, 1955, p 66) includes facilities for automatically diverting the coal from one car to another, controlling the hoist moving the trip, and starting and stopping the belts. Even cars off the track are provided for.

SWITCHING COAL

The problem of switching coal flow from one car to the next in continuous trip loading can be met in a number of ways. One is the overlapping mine car or articulated trip in which facilities to bridge the gap are built onto the cars. Thus, there is no need to stop either conveyor or elevator, or trip, during loading.

Where the coal flow is not too great, means of preventing spillage during car change include a simple plate or chute to catch coal while changing is in progress. When the new car is in position, the plate in tilted by the boom man and then is slid around on the top edge of the car to its next position. A new wrinkle in equipment of this type is a plate with holes at one end to accommodate hooks suspended from the top. As the car moves ahead, the hooks hold the plate and eventually tilt and dump it into the next car.

Heavier flows of coal, as off a mother belt, usually require power or some other type of equipment for a quick change. Power equipment in-



TRIP-LOADING PLAN shown here involves circle tracks around the belt heads, permitting locomotives to move trips continuously without storing empties. The loop is completed at the slope bottom.

cludes the short reversible conveyor mounted transversely under the head of the main belt. Equipment without power includes a "pants chute" with flap gate to divert the coal stream from one car to the next.

Main Haulage

Whatever its type, the goals in main haulage are (1) ample capacity with operation scheduled to prevent any interruption of loading or mining at the face, and (2) operation with a minimum of manpower and equipment.

RAIL HAULAGE

One-Stage or Multistage?—Main haulage usually is in two stages, relay and main-line, with a few operations dividing it into relay, secondary and main. There is a disposition, however, to question whether multistage operation should be adopted automatically. One-stage operation requires heavy track to the belt head or other loading station, but the extra cost may be much more than offset by decreased haulage labor and maintenance costs. The possible savings warrant careful study of the question before the system is finally settled upon, or an existing relay system is continued.

Cars and Locomotives — Even though cars are less and less taken to the face, where size has an appreciable effect on loading-machine productivity, capacity still is an important factor even in main-line service. One argument for the biggest possible car is that it costs relatively less to buy big cars than small cars. A second is that the big car holds more coal per pound of car weight, and therefore less dead metal has to be dragged around for the same coal delivery.

In the case of locomotives, if one big one can replace two smaller ones, there is an obvious saving in labor. Or two smaller units can be made into a tandem job to get the same saving. In at least one instance also, three small machines were tripled into a single 12-mph unit with spectacular savings (*Coal Age*, September, 1952, p 76). Accompanied by reconstruction of the haulageway and the installation of big cars, the triple-header was delivering 4,500 tons over a 4½-mi haul with two men, compared to 4 and sometimes 5 locomotives and 8 to 10 men for 3,500 tons previously. More recently, a single 50-ton machine capable of pulling 1,600 tons on a straight, level track (*Coal Age*, January, 1954, p 111) has gone into service.

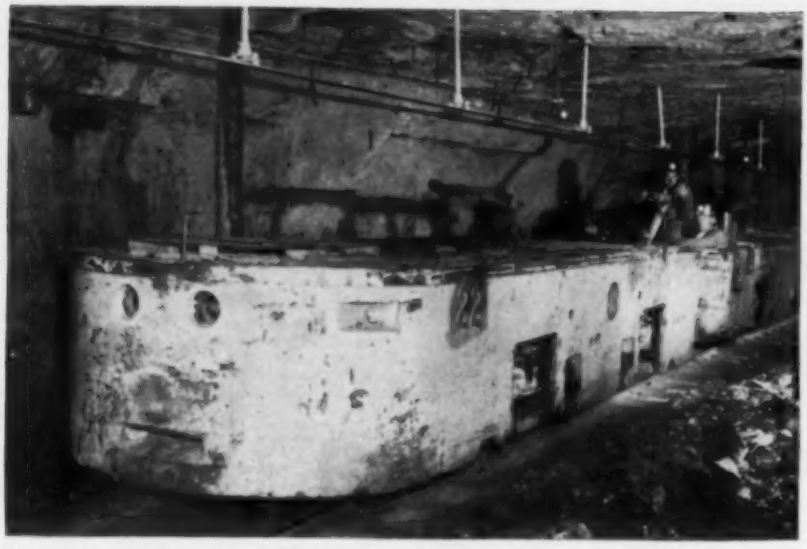
Aids to safety, efficient operation and low maintenance in car design include:

1. **Automatic couplers.**
2. **Spring draft and buffing gear.**
3. **Antifriction - bearing wheels.** With high speeds and swivel trucks, as in 8-wheel designs, wheel metal and treatment becomes a more critical problem. Answers include special mixtures and chilling with cast iron, and cast or forged steel.
4. **Lightweight corrosion - resisting materials.** Newest in aluminum plate, shapes and extrusions for maximum weight reduction. Another form of construction for simplicity and strength with minimum weight is the use of standard structural shapes—for example, channels for sides and ends on low-vein cars.

Antifriction bearings also mark the modern locomotive, which, especially in main-line service, tends toward a higher rated speed, usually 12 to 15 mph, with certain types rated up to 35 to 40 mph. Modern electrical controls include provision for dynamic braking where grades warrant. For absolute reliability in such braking, a 32v battery permits continued operation even when trolley power fails. Cabs with ample room and with bumper extensions high enough for complete protection of both motorman and triprider promote comfort and safety.

TRACK

Generally accepted standards for good main-line track include 70- to 90-lb rail on heavy treated ties laid



MODERN TRACK CONSTRUCTION, including heavy rail, treated ties, good ballast and good drainage, increase haulage efficiency.

BELT HAULAGE is facilitated and the belt life is increased by proper installation and protection, such as turn chutes at junctions.

in crushed slag, gravel or cinder ballast. Welding has come sharply to the fore as a means of joining rails, with steel arc the most widely employed. Curves should have a radius of 300 to 500 ft and should be superelevated. Turnouts should not be less than Nos. 5 to 8. Trolley wire should be hung at a uniform height above the rail and aligned with it at the proper distance outside. Shoe-type collectors should be used where feasible, especially on heavy-duty locomotives, and the trolley wire should be adequately lubricated at the proper time intervals for low maintenance and efficient current collection.

Throws and switch-position indicators are essential for safe, smooth maine-line haulage, while alloy frogs and proper guarding keep down maintenance and reduce derailments. Automatic switchthrowers and remotely actuated derails save labor and promote safety.

Double Track or Single?—Most authorities agree that double track is for the big mines, though they split on what is "big." Advantages of double tracking include complete separation and no interference between empty and loaded haulage. Also, since waiting at sidetracks and passing tracks is eliminated, fewer cars and locomotives are required. Furthermore, one track usually always is available and therefore production seldom if ever is completely interrupted. In addition, some mining men point out, double tracking where grades are heavy makes it unnecessary to use a tail locomotive, which might otherwise be considered necessary. Also, it permits installing spring-type derails on upgrades.

Almost the equivalent of double tracking can be attained by proper location of properly designed passing tracks, though where several locomotives normally pull to the bottom it might be desirable to double track the portion of the main line handling, say, 75% of the mine tonnage. An alternative is a marshalling yard at the point where all the tonnage, or most of it, comes together, with a single-track single-locomotive stretch to the portal, and single track with passing tracks inby the yard, perhaps supplemented by some double track. In view of these and other alternatives, careful study of the problem is essential to arrive at the correct answer.

Drainage—Mud and water can reduce the capacity of a haulage system as much as one-third or more. Proper ditching is a major answer to keeping haulage roads dry. If gravity disposal is impossible, sumps should be constructed to receive the water and facilitate disposal by pumping. The importance certain mines ascribe to dry haulage roads is attested by a program of building cisterns in crosscuts at strategic points and equipping these with automatically controlled pumps discharging to an outside line. Incidentally, mine water may also be diverted for sprinkling at the face since it has to be handled anyhow and might as well be bled out of the main discharge system.

Grading—Eliminating humps and hollows not only makes for smoother, safer haulage but also can result in a significant saving in number of locomotives and crews necessary for a given tonnage. If possible, sustained grades against the loads of over 1¼ or 1½% should be avoided. If averages higher than that cannot be avoided, then it is even more essential to knock off peaks.

One problem is synchronizing grading and main-line extension with face advance to permit the latter to go ahead efficiently while at the same time providing enough open length so that a proper profile can be arrived at. In most instances, a stretch of 1,000 to 1,500 ft is necessary to fix the profile and thus determine where and how much grading must be done. Two suggestions for providing this distance are: (1) use a belt conveyor in advancing the entry, or (2) lay light track in a side heading to serve while advancing the headings and bringing up the heavy steel. If it is felt that the investment in a belt for this limited use is high, track is

lower-cost alternative, though not quite as convenient.

Track Cleaning—Smooth, faster haulage, less track deterioration and greater safety are the major reasons for emphasis on clean track. Track-cleaning machines naturally reduce the cost to a minimum, while cars in good condition reduce spillage and stretch out the intervals between cleaning. In many instances, a considerable tonnage of good coal is reclaimed in the cleaning process, which might well be credited against cleaning cost. Some mines, as a matter of fact, figure they are well ahead of the game by salvaging coal off the track.

HAULAGE CONTROL

Except where the haulage system is of the simplest type, the dispatcher is essential not only for efficiency in haulage but also as a means of keeping a finger on conditions and progress throughout the operation for the benefit of the foreman and superintendent. In his business, he uses not only the regular telephone but, along with other mine personnel, the carrier-current phone—on locomotives and cages as well as in offices and stationary communication posts throughout the mine.

Ready communication with locomotive operators is the great advantage of the carrier-current instrument, the use of which some mine managers have stated has raised output and efficiency 10% or more. For better coverage of key points at a practicable cost, at least one mine (*Coal Age*, December, 1954, p 67) has supplemented carrier-current equipment with "loudspeaking telephones." These are tied in with the carrier-current system, including the locomotives, and are provided with auxiliary battery power to permit communication if the power goes off. As an example of how the units extend communication range, it is now easy for the boomman at the belt discharge, for example, to talk to the shuttle-car operators feeding to the belt, as well as to the locomotive operators and outside stations.

Block signals at times can take over in part or completely in control of haulage, aside from their other major function of preventing interference and collisions. Normally, however, in the control area, they supplement and round out the dispatching program, making it, in the experience of many mines, more accurate and efficient.

BELT HAULAGE

Because of the increased difficulty and cost of setting up and maintaining an efficient track haulage system in thin coal where top or bottom must be taken, the belt conveyor, with a few exceptions, first made its mark in underground transportation in low-vein operations. It was of particular benefit in eliminating brushing and providing continuity of transportation in panel haulage, which normally aggregates several times main-line haulage over the life of the property, and was a natural complement of conveyor transportation in rooms. Since that time, the belt also has moved into thick-coal mines for both main-line and panel service. The reasons for one installation in thick coal, where the output will aggregate 1,000 tph, include the following:

1. Less manpower in building up and maintaining rated tonnage.
2. Less routine deadwork (brushing, grading, timbering, etc.) in establishing and maintaining haulage.
3. Fewer haulage delays, with consequent increase in face productivity.
4. Fewer haulage accidents.
5. Greater concentration of production with greater overall efficiency.

In this installation, a separate rail system for handling men and supplies was installed, with the result, according to operating management, that men and supplies are handled more efficiently while at the same time there is no possibility of interfering with coal haulage.

One secret of efficiency in main-line belt haulage is proper installation according to the recommendations of the conveyor and belt manufacturer. Another is the employment of one man properly trained and equipped to patrol service and lubricate each 1½ to 2 mi of belt line. A third is proper loading of the belt. Chutes should turn the coal in the direction of the belt, lay down a cushion of fines and, if possible, put the coal on the belt at the same speed. In a few high-tonnage systems, short speedup belts are used to turn coal from panel belts and deposit it on the main-line units in the right direction and at the right speed. Thus, the punishment is largely confined to the speedup unit. Big lumps, incidentally, require a wider belt, a heavier carcass and proper covers. Cushion idlers at transfer points are essential in helping protect the belts. Good splicing is a must.

Measures to prevent ignition and retard fire propagation include the following:

1. Use of neoprene, which also improves troughing and lengthens life.
2. Preventing or protecting against drive-pulley slippage, including automatic counterweighted takeup and devices to stop motor when belt slows down or stalls for any reason.
3. Preventing stuck idlers by proper lubrication and service, supplemented by good housekeeping to eliminate material that might be ignited.
4. Following proper inspection and maintenance methods to eliminate rubbing of belt against the frame.
5. Removing electric cables and other possible sources of ignition to parallel openings.

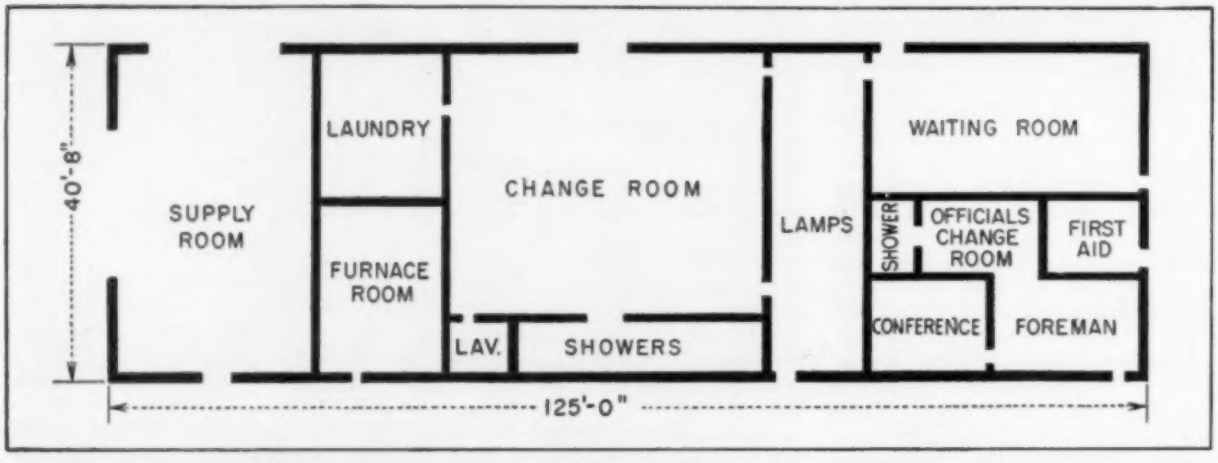
Suggestions for electrical control and protection include:

1. Connecting each drive to the line through a stepped resistance.
2. Sequence starting, outby drive first, with proper time delay for each subsequent drive.
3. Automatic stopping of all inby conveyors or elevators if any belt should stop for any reason. The usual device is a centrifugal switch.
4. Interlocking conveyors or elevators feeding to a belt to prevent feeding onto one already full loaded. Devices include finger- or paddle-actuated switches, as well as the skate-wheel spring contact-maker described on p 40 of this section.
5. Providing overload or pileup protection at belt transfers, using paddles or other devices to actuate switches and shut down the inby drive. These switches should be of the momentary-contact-type so that the inby conveyor will start again when the overload is cleared.
6. Providing a means of stopping the conveyor anywhere along its length to permit the beltman or any man riding to stop the belt at any time. Continuous pull-cord type controls fastened to the roof also provide protection against falls.
7. Providing a drive-pulley slippage control to stop the unit as soon as slippage occurs. A centrifugal switch with pulley riding on the belt, or a centrifugal switch driven by a chain from the bend or snub pulley, are two possible devices. A third is a differential control with two pulleys, one riding the belt and the other the drive pulley so that when one gets out of step the drive is stopped.

Belt Cleaning—A number of devices, each more or less satisfactory, have been developed for cleaning belts before they go onto the return idlers. A recent one apparently coming closest to the ideal is a length of piano wire mounted under the head pulley and almost touching the belt (*Coal Age*, November, 1952, p 89).

MAN CAR FOR LOW COAL is self-propelled and has capacity sufficient for an entire face crew.

WHERE WALKING UPGRADE is involved, as in slopes, "ski-tows" ease the pain, especially at shift end.



NEW SERVICE BUILDINGS for mine portals feature ample facilities for both supervisors and men, plus maximum convenience. This particular building includes a small supply room and a towel laundry.

Hoisting

In the absence of special circumstances, the belt slope is the usual coal-hoisting facility installed today. Low operating labor and low maintenance are the major reasons, while improvements in belt design, including rayon, nylon and steel-cord tension elements, have made it possible to install single belt runs up to 3,000 ft or more in hoisting, thus raising the vertical lift to more than 800 ft.

The British-developed cable belt is a possible new contender in hoisting service, with one installation over 3,000 ft long scheduled to go into service in Canada toward the end of 1955. In the ordinary belt, much of the carcass weight and thickness represents strength in tension to permit the load to be moved without pulling the belt apart. In the cable belt, the pulling is done by wire ropes, one on each side and independent of the belt. Shoes incorporated in the belt, or more recently a grooved edge molded onto the belt, rest on the ropes and provide enough friction for pulling the belt and the load along.

Belts also work equally well in lowering coal where the terrain permits their installation at inclinations of under approximately 20 deg. Other facilities for lowering include monitors and rope-and-button conveyors.

Any of the standard types of dumps may be employed in transferring the coal from mine cars to the belt, unless bottom-dump equipment is employed. A necessary intermediary is a hopper or bin. Where belts are used for main-line haulage, boomed shuttle belts (see "The Preparation Guidebook" for example) are used to lay the coal down in a longer and therefore larger-capacity bin. Short transfer and speedup belts also are used between hoppers and slope belts to take the shock and protect the slope unit from some of the wear and tear. Magnetic tramp-iron-detection equipment on either the speedup or main slope belt stops the equipment and permits removal of metal that might result in damage.

The tendency is to make hoppers and bins feeding slope belts of a size to hold at least 15 to 30 min of production. Unless, as frequently is the case with dropbottom cars, the trip is

pulled through the dump by the locomotive, power trip feeders and trip makers should be employed for efficient car handling. Properly placed and operated sprays keep dust within reasonable limits. An alternative is a hood and duct system with collectors either above- or below-ground. In some instances, trip feeding, dumping and trip making are completely automatic by virtue of the necessary starting, stopping and limiting switches.

Belts may be and are used in hoisting between levels, or from the face to the surface where seam pitch is not over 18 to 20 deg. Above that, some form of rope hoist is required. It usually is a single straight drum powered by an AC motor. Lowering is made more efficient and smoother by installing DC dynamic braking.

SHAFT HOISTING

The skip hoist usually raises the equivalent of 2 or 3 cars each trip and thus normally can operate more slowly, with lower acceleration peaks. Where self-dumping cages are employed, fabricating them of high-strength alloys or aluminum reduce dead weight and consequently improve the hoisting operation. Where platform-type cages are employed, the British have developed the "container" idea to speed up hoisting and materially reduce labor. In this system, the coal is dumped into hoppers from which it is chuted alternately into two containers with bottom doors on which regular flanged wheels are mounted. As a container is filled a ram shoves it onto the cage, moving the empty container off for refilling. At the top, the process is reversed, and the container is dumped automatically by permitting the bottom door to swing down.

As with all other mining operations, economy in hoisting is a matter of equipment and controls to conserve manpower. Now, any type of vertical hoist—skip, self-dumping or overturning cage, and platform—can be made completely automatic, including caging and, with platform equipment, decaging. Even if complete automatic operation is not desired, automatic cagers, trip-makers and the like speed up the hoisting process and save labor.

Handling Men

In these piping portal-to-portal days, a major consideration in designing facilities for handling men is keeping travel time to a minimum. As an example, if actual working time is 6¼ hr, or 375 min, increasing it 15 min is equivalent to producing the same tonnage with 1/25th fewer men. Greater time savings enhance the benefits and increase the limit of expenditures to secure them. At an average of 6 mph for a mantrip, if permitted by law or regulations, cutting the distance 2 mi saves 40 min per man in production time.

Portal relocation, among other things, provides an opportunity for streamlining the handling of men and also attaining maximum convenience and comfort in changing in and out. A collateral benefit is an up-to-date field supply setup, with possibly also a field maintenance shop that much nearer the active workings. Aside from supplies and maintenance, key objectives in portal design include:

Ample all-weather parking.

Good wash and change facilities.

Good lamphandling facilities.

Offices and meeting places for supervisors.

Protected facilities for men waiting to board trips—from weather and electricity particularly.

Adequate first-aid facilities.

The plan shown in the accompanying illustration also includes a laundry for towels, which are furnished in this instance at a small fee to men who desire this service.

HOISTING

Where men are handled through separate man-and-material shafts, either at the main opening or back at field portals, usual practice today is to install pushbutton-operated elevator-type equipment in capacities up to 50 men, which reduces the total time required to put a crew into the mine car or bring it out. The cage may also be adapted to handling heavy supply items, though the tendency is to use the regular opening for this purpose, especially if it is a drift or slope.

Where men enter through slopes, some mines, where the regular equipment cannot be employed, provide special slope cars for that part of the trip. If single cars are employed, the trend today is to equip them with magnetic track brakes actuated by an overspeed device or by a pushbutton under the control of a foreman or triprider. Where several cars are put together in a trip, they can be preceded by a pilot car with magnetic-brake equipment. If men walk the slope, a "Ski-tow" installation, which gives them a one-handed pull, is a major help in negotiating the stairs in the "up" direction.

CAR TRANSPORTATION

Where height is sufficient, the covered mantrip car is practically standard for transporting men by rail. In addition to cars pulled by locomotives self-powered units are available in capacities up to full section crews, making it unnecessary to detach locomotives for this service. Where several individual cars are in service, dispatching and block signals are essential to prevent collisions. At trackless mines, corresponding equipment on rubber, and with battery power, is available.

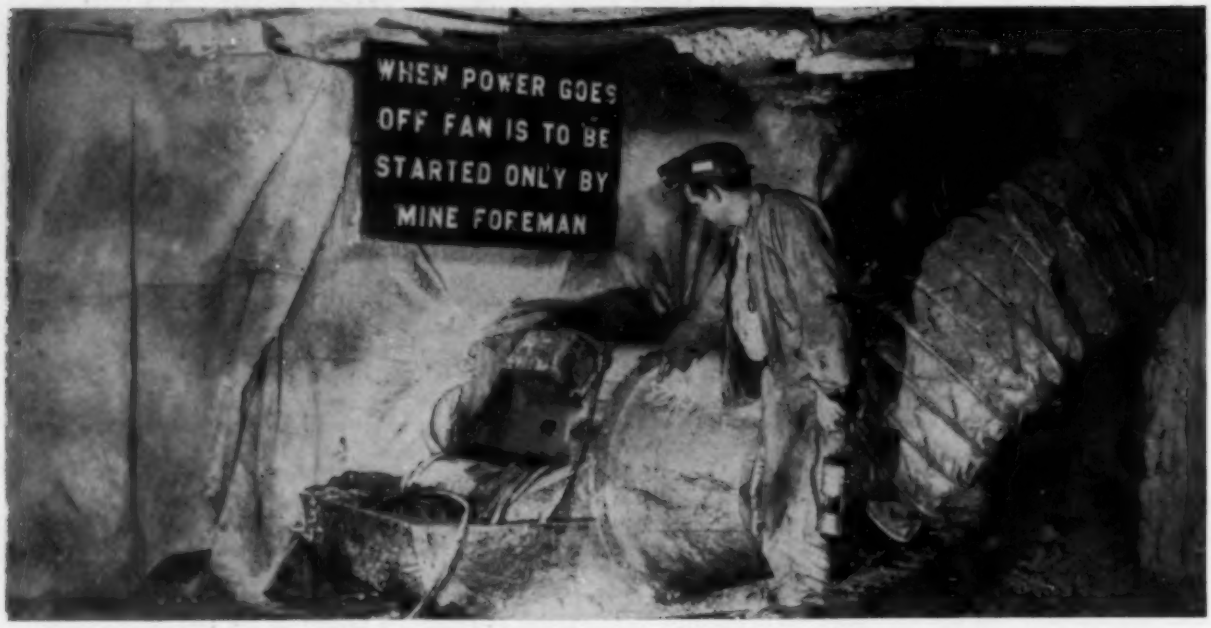
Low coal makes it more difficult to cover cars that go into areas where top is not taken. Flat-bed rail cars with rubber mats can be used, with the men lying crossways. Self-propelled types include one in which the men lie down with knees up in each end (*Coal Age*, March, 1954, p 190). Capacity is sufficient for a section crew of 11 men. Height over the rails is 24 in. As in thick coal, equivalent equipment is available on rubber for thin-coal operations.

In addition to regular mantrip cars, a variety of rail and rubber-mounted cars may be employed to save time and promote efficiency in transporting mechanics, electricians and repairmen, as well as officials. The list includes even small one-man three-wheeled "trikes" for trackless operations. Types for mechanics, electricians and repairmen include tool and supply boxes and wells or decks for carrying heavy items.

BELT TRANSPORTATION

Under proper safeguards, movement of men on belts has proved both safe and efficient. The major safeguards include ample vertical clearance all the way, extra clearance at points where men get on and especially where they get off, equipment to reduce speed to approximately 200 to 250 fpm, and an emergency stop cord or stop system all along the belt so that any man can stop it at any time. The system should be designed so that the belt cannot be re-started without a check to see that no hazard is involved. A space of at least 6 ft must be maintained between each man on a belt.

Belts may be reversed to take men in, and a few mines have designed mainline systems with that in view. In going in, men necessarily must get off and change if more than one belt is in service. There also should be a rigid rule that men get off and change coming out as well. Ample clearance and smooth unencumbered footing should be provided at all loading and unloading points. Finally, in addition to all other steps, no movement of men on belts should be permitted except while a responsible supervisor is present.



THIS AUXILIARY FAN, with proper safeguards against misuse, exhausts air through flexible tubing from a continuous-mining section where line curtains were not fully effective. Brattice-cloth flap prevents recirculation (CA, Feb. 1955).

Ventilation

EXPERTS IN THE ART of ventilating coal mines agree that any effort to improve, modify or update a ventilating system must be based upon accurate pressure and velocity surveys of the mine in question. Regions of high resistance or excessive velocity must be identified, and the extent of wasteful leakage must be determined. Having this information to guide him, the ventilating engineer may then select the places where his investments in time and money will be most rewarded.

Basic Principles

Most of this effort is put forth with one eye on the power bill, since the goal is to provide adequate ventilation at minimum power. And following back from the power bill, it is seen that keeping the velocity of the air within reasonable limits is a basic requirement because (1) power varies as the cube of the velocity; (2) pressure varies as the square of the velocity, and (3) quantity varies directly with velocity.

A change in any of these conditions naturally forces a change in all others since all are interdependent. Furthermore, existing conditions at a particular mine, lumped together in the term equivalent orifice, finally determine the magnitude of the ventilating job.

But it is possible to change or control the conditions which determine the ventilating job. For example, doubling the number of airways to carry the same quantity reduces the velocity by half and the total power required by three fourths. Similar improvements in varying degree may be achieved by cleaning up airways to reduce resistance, sealing leakage, splitting and regulating in the most efficient manner, shortening the distance of air travel through the use of new airshafts and other such steps.

Even at mines where the ventilating duty is governed by the amount of methane made in the workings and the necessity of diluting it and sweeping it away, there is the possibility of draining off some of the methane through boreholes tapping the solid coal ahead of the mining. Thus it may be possible to ventilate at reduced velocity or with less volume.

In making the surveys upon which all these approaches to better ventilation are based, the ventilating engineer may employ sensitive altimeters or inclined manometers in determining the pressure gradient of the mine. Use of the altimeter permits rapid surveying, using the haulageways for traveling. Velocity surveys may be completed in minimum time through the use of a velometer, which is an anemometer calibrated to read velocities directly.

Ventilating Equipment

Today's mine fans are as efficient as the propellers of a sleek airliner, including even a modified "feathering" feature which permits changes in blade pitch as dictated by changing conditions. That makes it possible to select a fan that will continue to provide adequate ventilation at high efficiency as underground workings expand.

Better design in ventilating materials is not confined to fans alone.

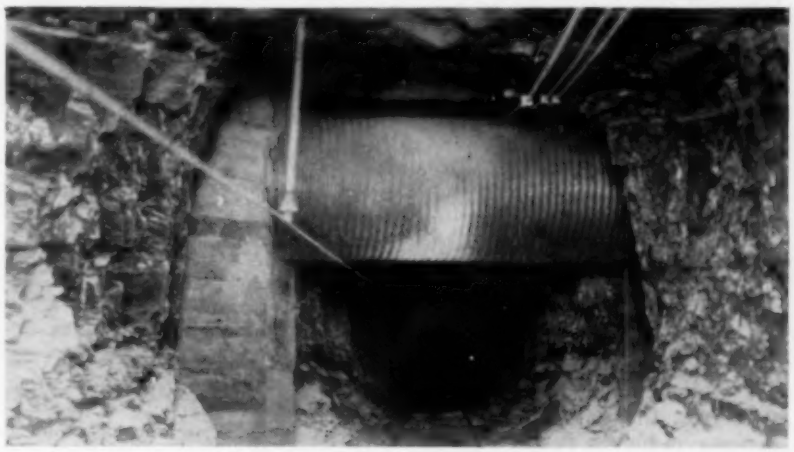
NARROW, TELESCOPING METAL SECTIONS permit quick erection of stoppings and doors and reclamation for further use. Sealing with caulking compound eliminates leakage. Door swings from steel jack for fast relocation.

Also available are improved curtain materials, including treated cloth and neoprene-coated types. Spad drivers have been developed to reduce materially the time required to install line curtains and checks.

New materials for stoppings include telescoping metal sections sheet plywood and plastic sheeting, as well as inflatable stoppings. Big features in both of these are rapid installation for savings in labor and full reclamation for savings in supply costs. Other materials include concrete blocks and sprayable coatings for sealing against leakage.

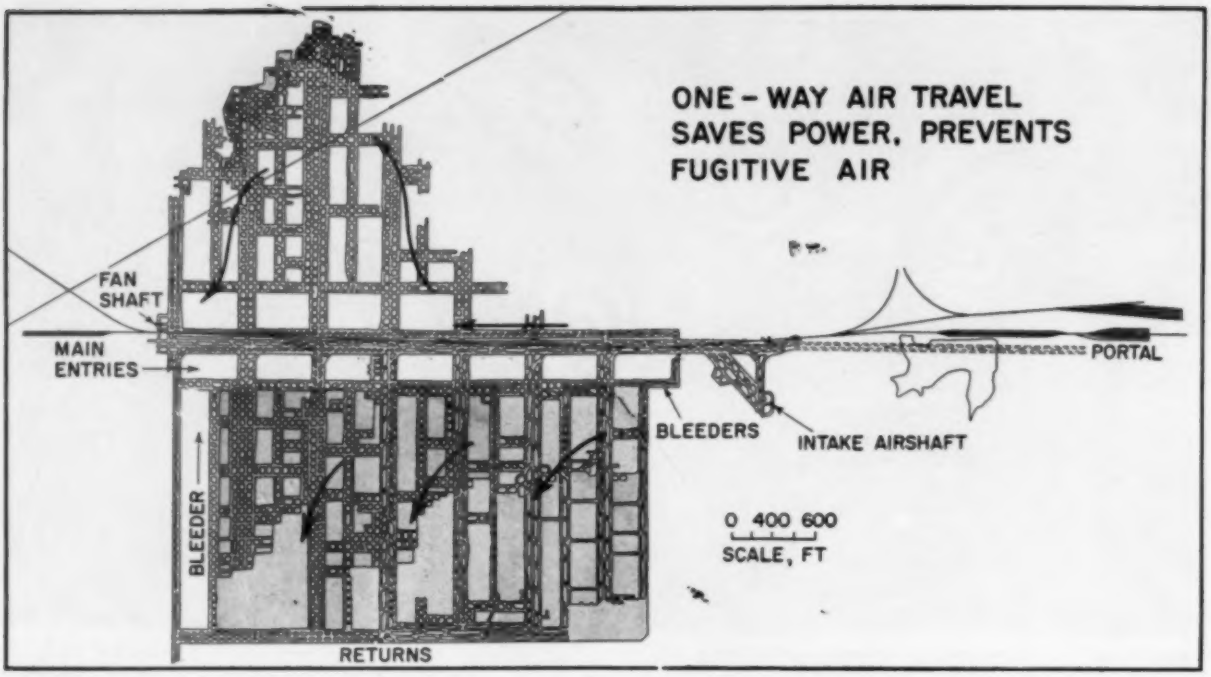
Prefabricated materials, corrugated pipe sections for example, may be used to construct air bridges, thus cutting the cost of such construction and permitting the use of more overcasts to the exclusion of doors and other wasteful air-current controls. As a result of these developments, overcast is no longer a bad word in designing ventilation systems. They are used more and more in modern mines as the best means of dumping used air into the returns with least ado or of initiating splits.

Auxiliary air movers, including fans and portable evase units for the control of compressed air, may be of some help when properly used with the approval of regulatory agencies. Better ventilation at a continuous-mining face has been achieved in one western Pennsylvania mine through the use of an auxiliary exhaust fan



OVERCASTS made of galvanized pipe like this, or from corrugated arch sections, are cheaper to build in the first place and may be reclaimed.

CLEANER, SMOOTHER ROOF SUPPORT with bolts provides increased airway area and reduced resistance to airflow, thus lower power costs.



DEVELOPING MAINS to intersect fan shaft was first operation at this modern mine to achieve one-way air travel.

and flexible tubing. Installed with safeguards against recirculation, the fan provides adequate air at a velocity which is sufficient to remove dusts to an appreciable degree, improve visibility at the face and dissipate the heat generated by the face equipment. In anthracite, trumpet-shaped air movers, connected to compressed-air lines, have been used to direct air to the faces of steeply-pitching places beyond the last open cross-heading.

Doors are a necessity at some point in every system. Recent developments in these include a new compressed-air-powered automatic door for heavily-traveled haulageways. The operating controls are actuated through the trolley system and all mechanical linkage and the operating cylinder are suspended from the mine roof and attached to the top of the door. None of the parts are exposed to wet bottom conditions nor to damage from possible derailments. Some mines now swing their conventional doors from steel jacks to make possible faster relocations.

Lower Power Costs

The advantages to be found in this modern ventilating equipment may be fully realized or they may remain undeveloped, depending upon the degree of care and skill employed in conducting the air through the workings. Excessive leakage and insufficient airway area are especially wasteful, no matter how efficient the fan.

Fugitive air is the most expensive luxury in today's coal mines—and the most dispensable. Surveys of some mines show that up to 80% of the air moving through the fan never reaches the working faces. It leaks through poor stoppings, around doors and so on, back into the returns without moving anywhere near the active sections. Even in mines where ventilation is given more serious consideration leakage may short-circuit up to 30% and more of the incoming air.

The penalties in fugitive air, measured in terms of wasted power, border on the tragic. Since a certain quantity at the face is mandatory, fan speed must be increased to insure that effective face ventilation, over and above leakage, will meet these legal requirements. And power consumption increases as the cube, while the increased velocity contributes to still more leakage.

Sealing at points of excessive leakage is one way to lick the problem. Another and better way is to look for ways to achieve one-way flow, thus eliminating leakage opportunities by doing away with side-by-side intakes and returns separated by porous stoppings and other leaky control devices. Airshafts or openings to the outcrop may be used as new fan locations or additional intake openings to get the one-way flow. Even in deep cover, the cost of a new shaft may be more than recovered in a reasonable time in power savings alone.

Furthermore, this one-way travel contributes to even bigger power savings inasmuch as a change to this system results in increased airway area with former returns now serving as intakes. The upshot is either reduced velocity for the same quantity or higher quantity at the same velocity, a bonus either way.

Assuming that a certain 100-hp mine fan moves 100,000 cfm to produce an effective quantity of 60,000 cfm at the face, only 35 hp would be required to move 60,000 cfm past the face if the 40,000 cfm leakage could be eliminated. In an area where energy sells for only 1c per kwh the power savings, figured in pure theory, would amount to about $4,237 per yr for continuous service. Preventing leakage and promoting one-way travel are real money-makers.

Splitting and Regulating

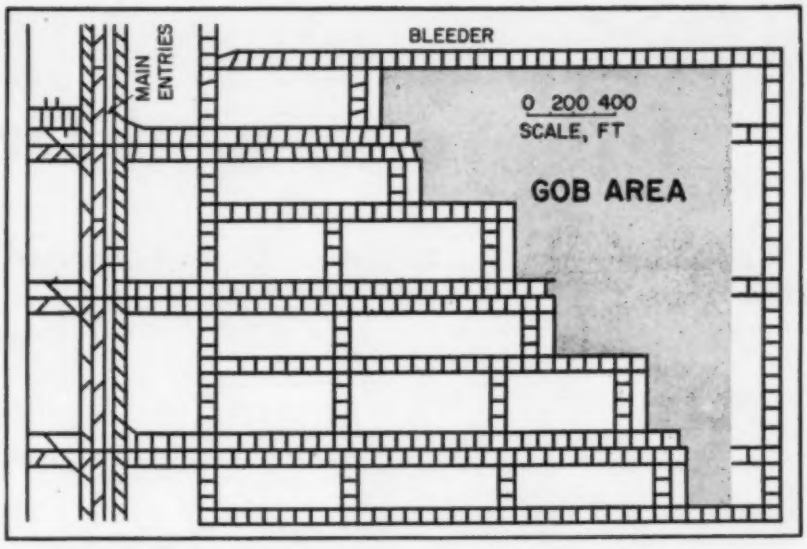
Increased safety is by all odds the big reason for splitting air currents underground. An explosion in a mine ventilated by one continuous current of air could affect the entire mine, while in a mine served by several splits the effects would be more confined.

There are other good reasons for splitting. The mine resistance is reduced, power is conserved, and better local control of the air becomes possible. Best practice in splitting requires that the splits be separated near the point of intake of the main current and rejoined near the point of final discharge from the mine to fully realize this improved control.

The ideal situation, which shows all splits naturally balanced in resistance, is seldom achieved in actual practice, since in some splits development work will predominate and, in others, room work. Some regulation becomes necessary to raise the resistance of all other splits to that of the longest or high-resistance split. Up to a point regulation is helpful, but it can become wasteful.

It pays to investigate the possibility of using an auxiliary fan to serve the high-resistance split alone, thus eliminating any need for adding resistance in the other splits. The benefits are reduced power requirements and lower pressure differentials on stoppings outby the booster fan.

Sometimes a well-planned cleanup in the free split may result in the passage of more air, also reducing the need for added regulation in all other splits. Some companies have found a ventilation bonanza by rehabilitating old airways with roof-bolt support in place of timbers. The resulting increased area and decreased resistance work together in compounding the benefits.



BLEEDER HEADINGS around gob areas increase safety by preventing accumulations of methane or migration of gas during low-barometer periods.

SHEET PLYWOOD, another low-cost stopping material, reduces installation time to about half that required for conventional wood stoppings.

Bleeder Headings

Accumulations of gas in worked out areas are especially hazardous in today's coal mines because of the rapid extraction in highly mechanized methods and the consequent increase in the rate of methane emission. The worked-out area increases rapidly, close by the active places where a number of electric-powered machines are concentrated and the entire crew is assembled.

In conditions like these, more and more operators are including bleeders in their mine projections to ring gob areas with openings through which air passing through the gob may be conducted directly to the returns. In some instances, air from the worked-out areas passes into the returns through regulators which control the quantity of air passing through gob as well as insuring adequate air and positive pressure along the pillar line. Properly maintained bleeder headings practically eliminate the possibility of gas migration through seals or otherwise during periods of low atmospheric pressure.

Along similar lines, it is advantageous in gassy conditions to begin recovery of room panels by driving a pair of line rooms along the outby limit of the panels parallel to the mains. Such rooms serve as an extra pair of low-cost airways, and the outby room may be preserved in the bleeder network after the panel has been robbed.

Supervising Ventilation

Tradition has it that it is top management's responsibility to provide the required quantity of air at the main intake, from where it becomes the responsibility of mine management to conduct it past the active faces in safe and proper manner. Everyone in the mine is vitally concerned in maintaining the system at highest-possible efficiency for safety and low cost.

But everybody's business has a way of becoming nobody's job, causing efficiency to wither. A modern mechanized mine should enjoy the services of a competent ventilation engineer in the same urgency as those of an electrical, mechanical or mining engineer. In most instances he will justify his salary in controlling power costs, to say nothing of the increased safety, better visibility and more comfortable working conditions that will result from his efforts.

Pumping and Drainage

CLEAN-STREAMS requirements may be a blessing in disguise. The best way to insure near-neutral effluent from a coal-mining property is to keep the water from running through the mine. This also happens to be the cheapest, surest way to handle the problem of mine drainage . . . two birds with one stone.

Diversion ditches around openings, sealed stream beds at troublesome points, new stream channels if necessary and well-constructed dams are possible controls which may be used to keep water out of underground workings. New flume materials, including even kraft paper impregnated with resins, now make it possible to conduct surface water across pervious areas of mining properties and dump it back into natural drainage channels on the other side. In round numbers, it comes down to this: For each 35 gpm diverted around a 100-ft-deep mine, a horsepower's worth of pumping capacity can be eliminated.

Gravity Drainage

But it is neither possible nor practicable in most instances to keep out all water. Some provisions must be made for handling underground inflow. Again it becomes a matter of seeking the cheapest way out of the situation, and that means taking fullest possible advantage of gravity flow, either to the outside or to a well-planned sump.

Other things being equal, it may be possible to lay out the mine so that workings advance to the rise, giving an assist to haulage as well as to drainage. Siphons may be employed in transporting the water over local rolls, thus continuing power-less water handling.

In other instances, it may be possible to drill boreholes to the cropline or into a sump area to permit gravity flow by the most direct path. At one mine, where some places necessarily are advanced to the dip, 2-in boreholes are drilled at the face through 60 ft of bottom rock to old workings in the seam below. The old workings are open to the outcrop, facilitating gravity drainage of both seams. This, too, is a possibility not to be overlooked.

When all's said and done, however, chances are you'll have to do some pumping. But handling water with today's equipment is a far cry from the brutal job it was in the past, assuming today's equipment is intelligently selected, properly installed and carefully operated. You have at your disposal efficient pumps for any type of duty, electric power in place of steam, automatic controls to cut the cost of operation and materials designed for long life at reasonable cost. You must provide a well-engineered drainage plan, first making full use of surface-water diversion and gravity-flow channels, then turning to pumping installations.

Recipe for Good Drainage

I. Keep water out of the mine:

1. Use ditches, dams and flumes around surface breaks.
2. Seal leaky stream beds with culvert pipe.
3. Grout broken strata where conditions permit.

II. Employ gravity if you can't keep water out:

1. Underground ditches or siphons consume no power.
2. Direct gravity flow to high-capacity sumps to concentrate pumping loads.
3. Open gravity drains to the outcrop, if possible.

III. Planned pumping costs less, is trouble-free:

1. Choose modern pumps with automatic controls to reduce attendance and maintenance costs.
2. Construct main sumps at locations where a minimum of gather-pumping will be required.
3. Use boreholes wherever possible to achieve straightline flow and minimum pumping distance.

IV. Control drainage costs with proper materials:

1. Select alloys that suit your water conditions.
2. Use large pipe for high capacity at minimum power.
3. Install lightweight pipe and fast couplings to reduce labor costs.

Pump Selection

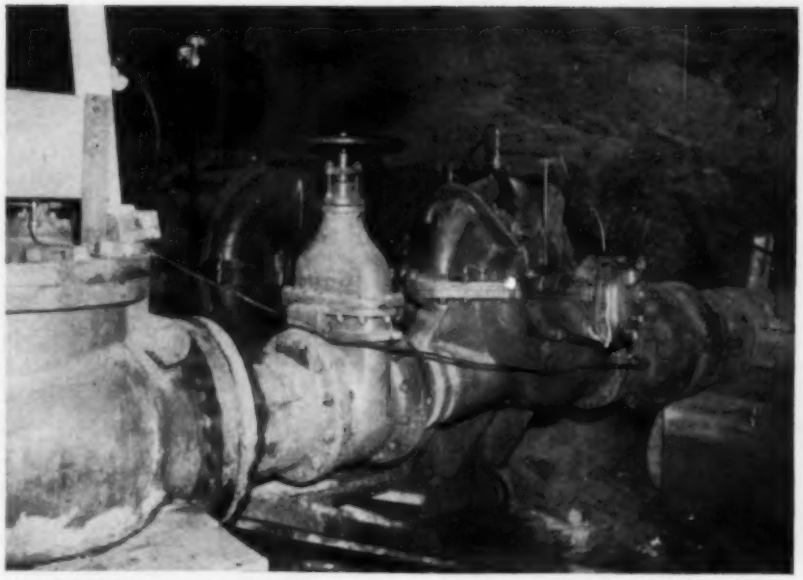
The type of pump you select depends entirely upon the pumping job you want done. In two out of three of today's mine-drainage applications, you'll find centrifugals of one type or another, but each of these is practically a tailor-made unit. The pumping job at one mine may be entirely different from that of its nearest neighboring mine with regard to such factors as volume, total head and water acidity. You're best bet, therefore, is to work closely with a pump manufacturer in determining the one best pump for your needs.

The final selection will depend upon whether the service is to be continuous or intermittent, whether AC or DC power is to be used, how much

water is to be handled, how much variation may be expected in suction and discharge heads and so on. Corrosion- or abrasion-resistance may be the determining factor, and the manufacturer will have to know this before he can recommend a pump.

For example, if the water is free of solids, you may select a multistage centrifugal unit to work against a high head, but if solids are present, you had better turn to a number of single-stage units in series for the same head because solids ruin multistage pumps. Thus pump selection becomes an exercise in balancing a number of sometimes-conflicting factors. Complete foreknowledge of the conditions under which the pump is to work is vital to successful selection.

Also important in selection is a decision as to whether the total pumping capacity should be provided in a single unit or in twins, with the latter choice getting the nod in most recent installations because of the resulting flexibility.



PROVIDING A GOOD PUMP is only one step in the process. You also need a piping system planned for long life and minimum maintenance.

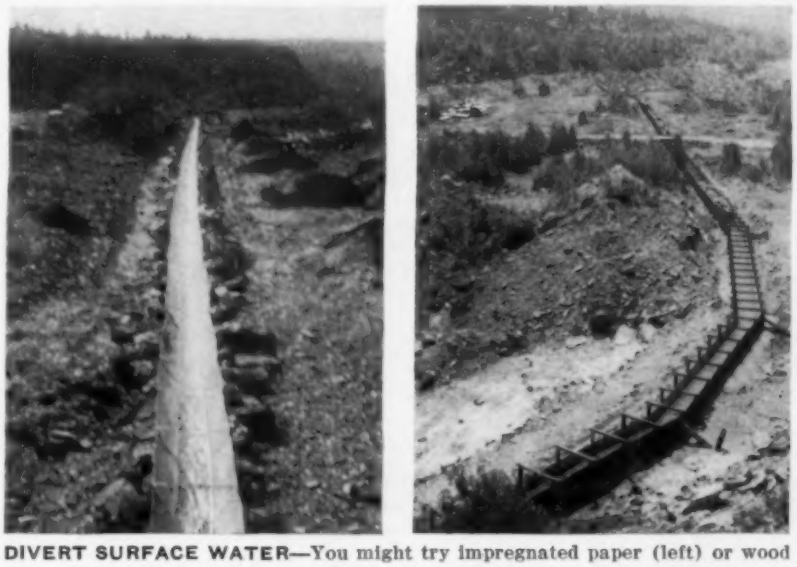
Planning Water Lines

The best pump in the world can be limited by a poorly-designed piping system. What are some of the factors to be considered in system design?

Usually the major variable which is amenable to some measure of control is the friction head in the piping itself. The quantity to be pumped is a definite figure and the static head is fairly fixed, but the friction head can be held to a minimum by designing for the largest-diameter straightest pipeline it is possible to achieve. Small pipe and numerous fittings and turns will extract a penalty in the form of either higher power requirements or reduced volume of discharge.

A standard 90-deg elbow for 6-in pipe is equivalent in friction tendencies to 16 ft of straight pipe, for example, and an open globe valve in the same line is equivalent to 160 ft of straight pipe. The reason for using a minimum of fittings is obvious. Tables showing straight-pipe friction equivalents of various fittings are found in a number of handbooks and should be used in pipeline layout.

In the normal case, pipe of the largest usable diameter will be most economical in the long run. With the length of the piping system and the number of fittings known, it will usually work out that the combined costs of piping, pump and power will be lower with large pipe.



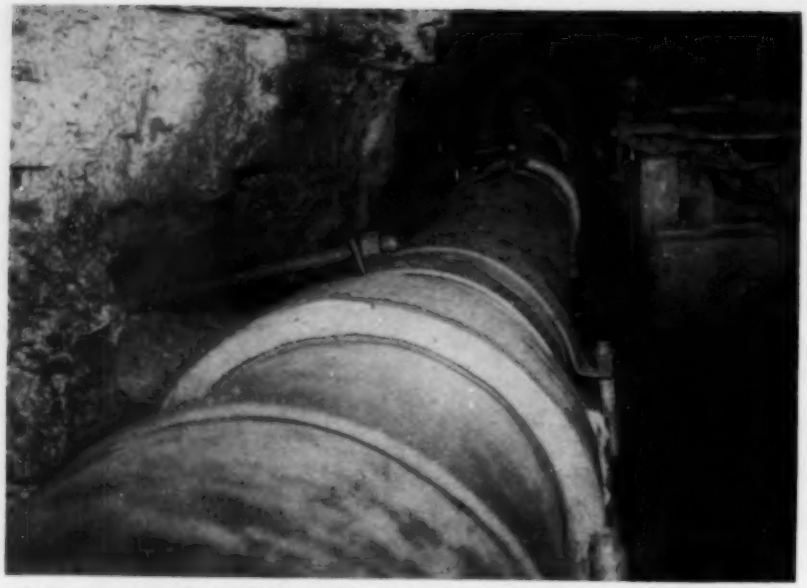
DIVERT SURFACE WATER—You might try impregnated paper (left) or wood flume, lined or not, as needed, to keep water out of the workings.

A well-designed pump installation will show these features:

- The suction line leads straight into the pump for a length equal to four to six pipe diameters.
- The suction pipe is one or two sizes larger than the pump nozzle, and it is connected to the pump through an eccentric reducer which is properly placed to eliminate suction-line air pockets.
- The drive motor and pump are in good alignment.
- The piping is supported so that the pump carries none of the pipeline weight.
- Priming auxiliaries, if they are needed, and lubricating facilities are in good working order.

Drainage Systems

Fitting the pumping system into the overall mining plan is another matter. This is another instance where each setup is somewhat different from any other, as local conditions dictate. An example of how to get the most out of a dollar of drainage cost is shown in an accompanying illustration, where three gravity-fed sumps and three pumping stations remove



HIGH HEADS AND LARGE VOLUMES in water lines call for stout anchorage like these floor and rib bolts to keep lines from kicking out.

MODERN SUPPLIES can reduce service labor. Fast couplings and plastic pipe are designed for this purpose.

3,000 gpm in three stages over a distance of 3½ mi. Each station is provided with independent pumping power through a borehole cable. Wood pipe in 8-, 10-, 12- and 16-in diameters is used.

The two main pumps at this property operate on alternate 12-hr cycles, thus making a peakless pumping load on the power system. The sumps act as accumulators in making this duty possible. If level power demand is important at your mine, either to head off penalties in the power bill or to prevent overloads on conversion substations, perhaps you could adapt this method to your needs.

At an anthracite mine the problem was to unwater some workings on the other side of a 200-ft barrier pillar to permit recovery of the pillars in the flooded mine. Broken strata above the workings ruled out the possibility of using a borehole to the surface. The solution, as shown in an illustration, was to drill a pair of 12-in horizontal holes from the active mine through the barrier pillar to tap the flooded workings. The borehole lines were connected to a 7,000-gpm 700-hp pump which discharged through 2,300 ft of 18-in asbestos-cement pipe installed in the slope of the active mine.

It was found in this job that it was possible to locate the pump at an elevation where a positive head on the suction lines could be used to balance a portion of the discharge head against which the pump had to work, thus saving power. And it was found also that the most difficult part of the job was restraining the 18-in discharge line with the pump operating at full head. The solution to this required the installation of steel bands bolted to floor and rib around the pipe on each side of each joint.

The pump and its drive motor were mounted on mine-car wheels to make it easier to replace either unit in the event outages occurred.

At another anthracite property, it proved to be more advantageous to drill two 24-in boreholes from the surface to a depth of 537 ft to reach the best natural sump in a worked-out lower vein. Upper veins then could be drained into this sump through smaller boreholes which were drilled at intervals as the workings advanced to keep the pipelines to gathering pumps as short as possible. The two larger boreholes each serve a 4,400-gpm 10-stage pump, driven by a 700-hp 4,000-v AC motor.

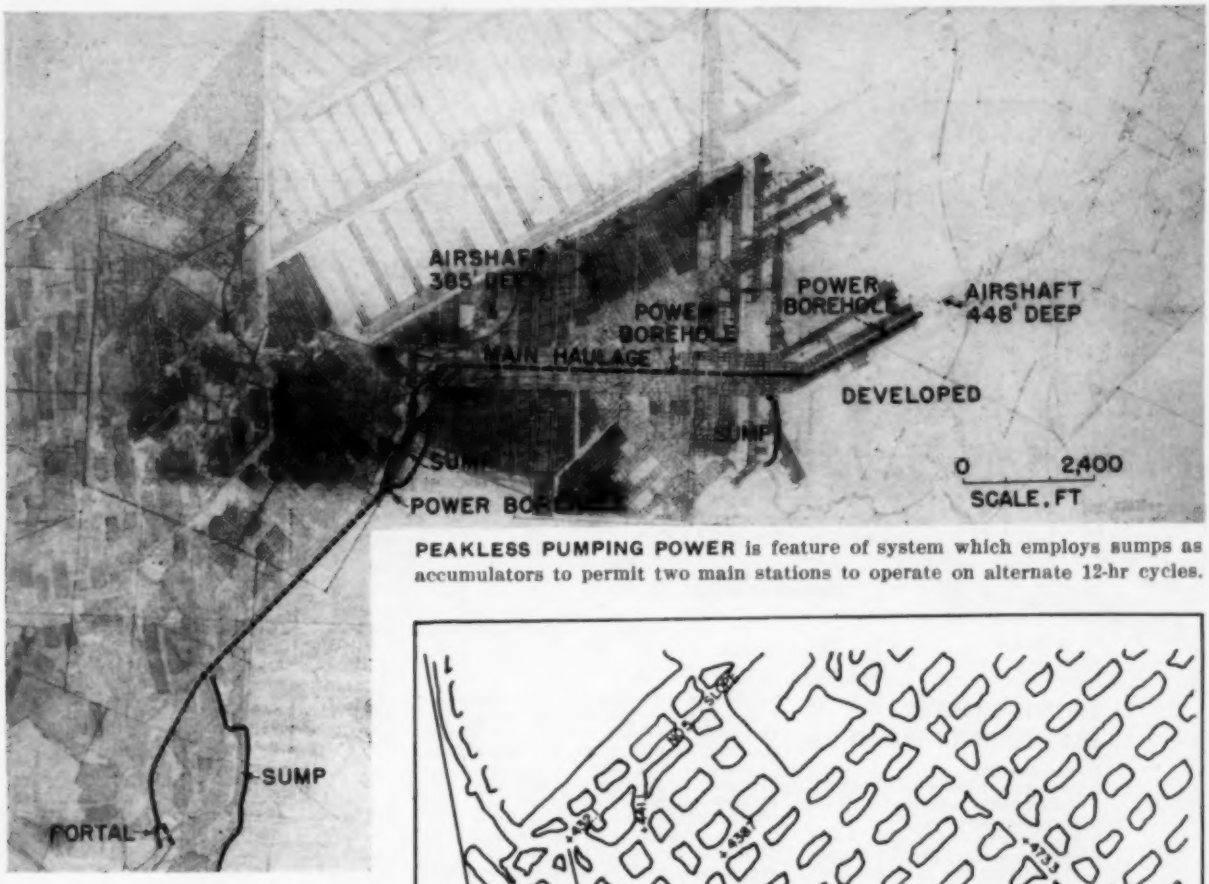
Incidentally, both of these anthracite drilling operations were let out on contract to a company that specializes in these projects. When jobs of such magnitude must be done, it pays to get the best services available.

Cutting Drainage Cost

So far, your drainage plan has been built up to take full advantage of the economies in surface-water diversion, gravity handling wherever possible and proper pump selection and application. There is one more requirement to be satisfied. That is, the system must now be operated and maintained with minimum expenditure of service labor. This means that pumps and other drainage equipment must give longer trouble-free service, pipelines must last longer, relocations of pumps and piping must be made in less time, and long runs of piping must be installed in the shortest possible time. Drainage costs can be kept under control only to the extent that these goals are met.

You have a lot of help in meeting these requirements. Every manufacturer of drainage supplies designs his equipment to perform one or more of these functions. Here are some examples.

Providing Trouble-Free Service—Modern pumps can be made of special alloys or lined with coatings which increase pump life in handling corrosive waters. Furthermore, control engineering now makes it possible to operate remote stations with vir-



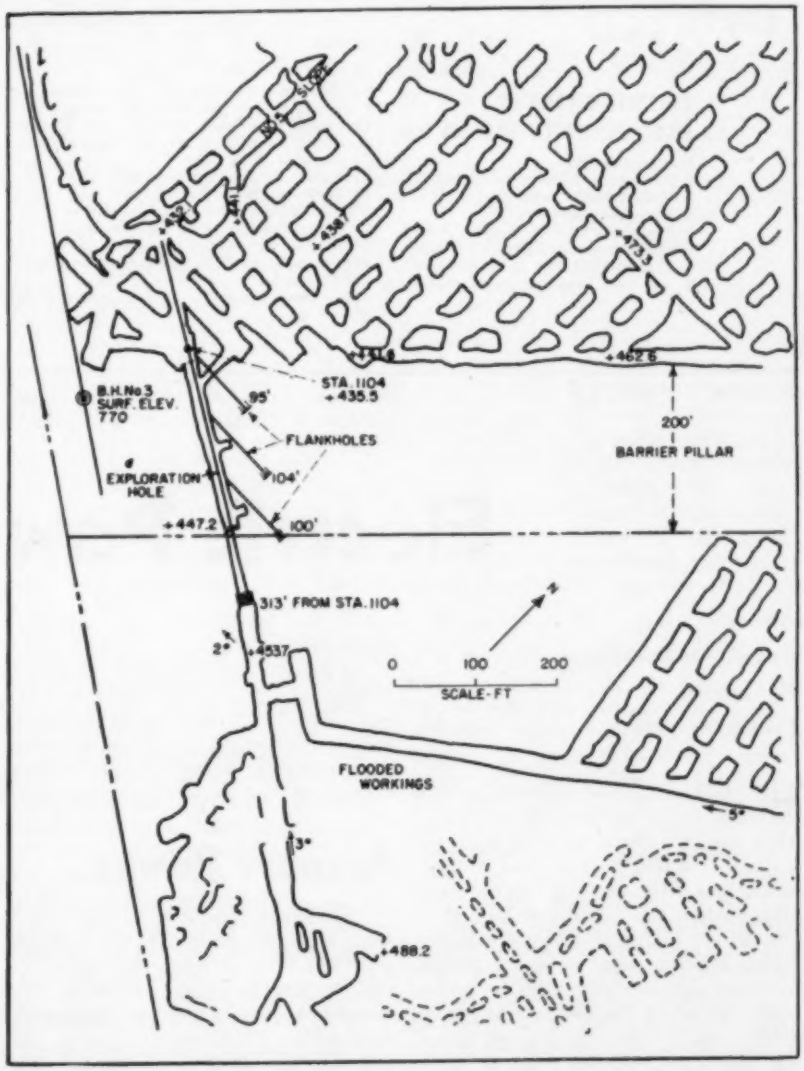
PEAKLESS PUMPING POWER is feature of system which employs sumps as accumulators to permit two main stations to operate on alternate 12-hr cycles.

tually no attendance. In either case, the cost of maintenance labor is rock-bottom.

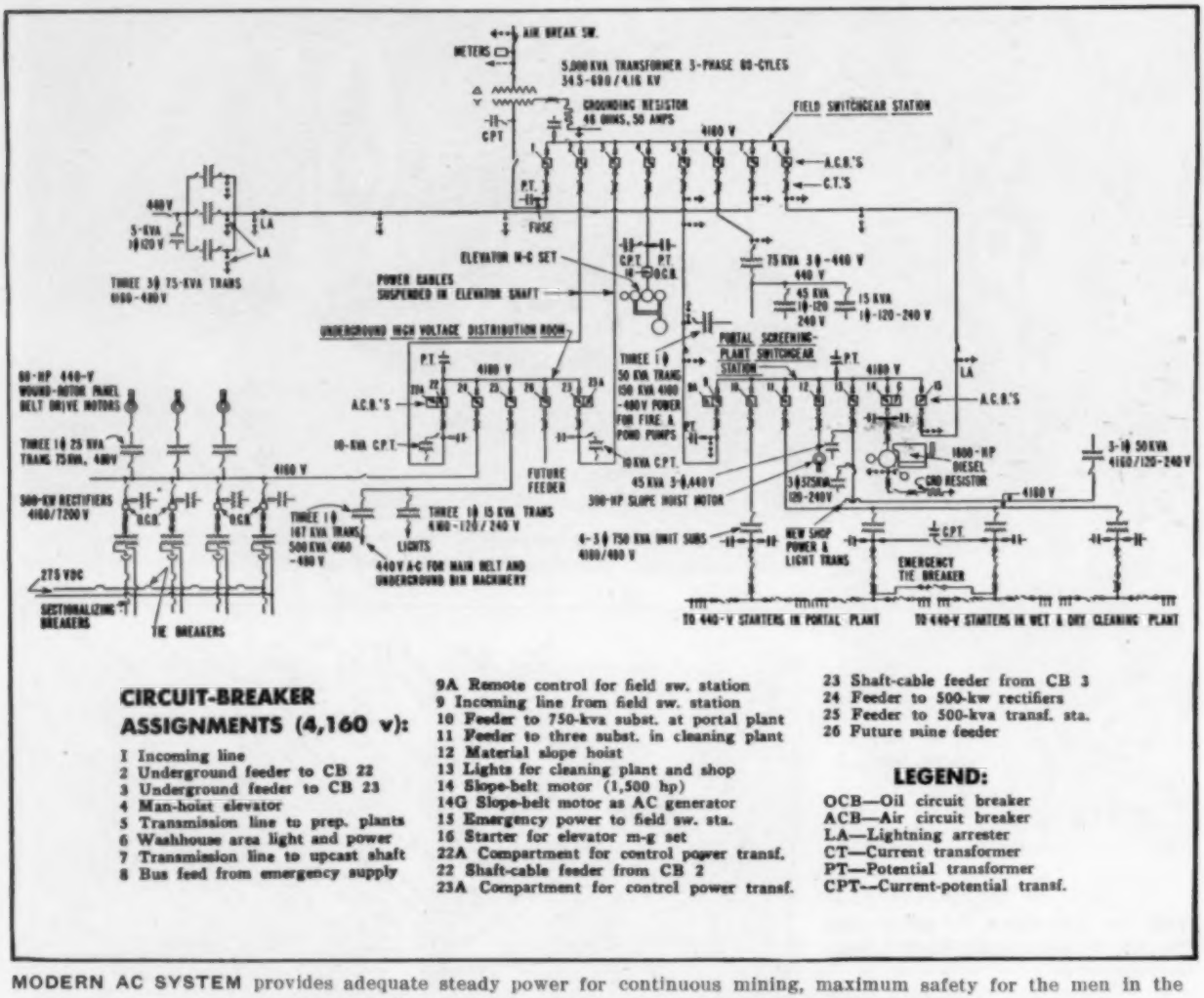
Longer Pipe Life—Asbestos-cement, plastics, aluminum alloys, synthetic rubber, special coatings—all these materials in the form of mine pipe have materially increased the time-in-service for underground pipelines. The happy result is that since fewer pipe changes are necessary, the drainage system can be maintained with fewer men.

Faster Relocation—Fast snap-action couplings for use with plain-end pipe now permit fast disassembly and reassembly in a new location of pipelines up to 6 in in diameter. Grooving machines now are available for modifying plain-end pipe to take the faster self-aligning couplings. And the latest is a new tool that rolls a groove into thin-walled lightweight pipe to permit use of fast couplings.

Quick Installation of Longer Runs—Long coils of lightweight plastic pipe or long sections of aluminum pipe now can be installed by one or two men, where the same men formerly would be hard-pressed to lay a fraction of this length in the same time.



HORIZONTAL BOREHOLES, another drainage possibility, permit flooded workings to be unwatered through lines in active mine.



CIRCUIT-BREAKER ASSIGNMENTS (4,160 v):

I Incoming line
2 Underground feeder to CB 22
3 Underground feeder to CB 23
4 Man-hoist elevator
5 Transmission line to prep. plants
6 Washhouse area light and power
7 Transmission line to upcast shaft
8 Bus feed from emergency supply
9A Remote control for field sw. station
9 Incoming line from field sw. station
10 Feeder to 750-kva subst. at portal plant
11 Feeder to three subst. in cleaning plant
12 Material slope hoist
13 Lights for cleaning plant and shop
14 Slope-belt motor (1,500 hp)
14G Slope-belt motor as AC generator
15 Emergency power to field sw. sta.
16 Starter for elevator m-g set
22A Compartment for control power transf.
22 Shaft-cable feeder from CB 2
23A Compartment for control power transf.
23 Shaft-cable feeder from CB 3
24 Feeder to 500-kw rectifiers
25 Feeder to 500-kva transf. sta.
26 Future mine feeder

LEGEND:

OCB—Oil circuit breaker
ACB—Air circuit breaker
LA—Lightning arrester
CT—Current transformer
PT—Potential transformer
CPT—Current-potential transf.

MODERN AC SYSTEM provides adequate steady power for continuous mining, maximum safety for the men in the mine, and full protection for mechanical and electrical equipment.

Electric Power

THE FINAL TEST of an underground electrical supply system—or any electrical supply system, for that matter—is whether it will deliver rated voltage to the motor terminals at normal running loads. As a matter of fact, if it can deliver higher than rated voltage, within limits imposed by motor design—usually not over 10% over or under rating—so much the better. At heavy loads, a slight overvoltage might mean the difference between a lot of cable trouble and no more than normal. With AC, of course, a good power factor also is necessary for the best in service.

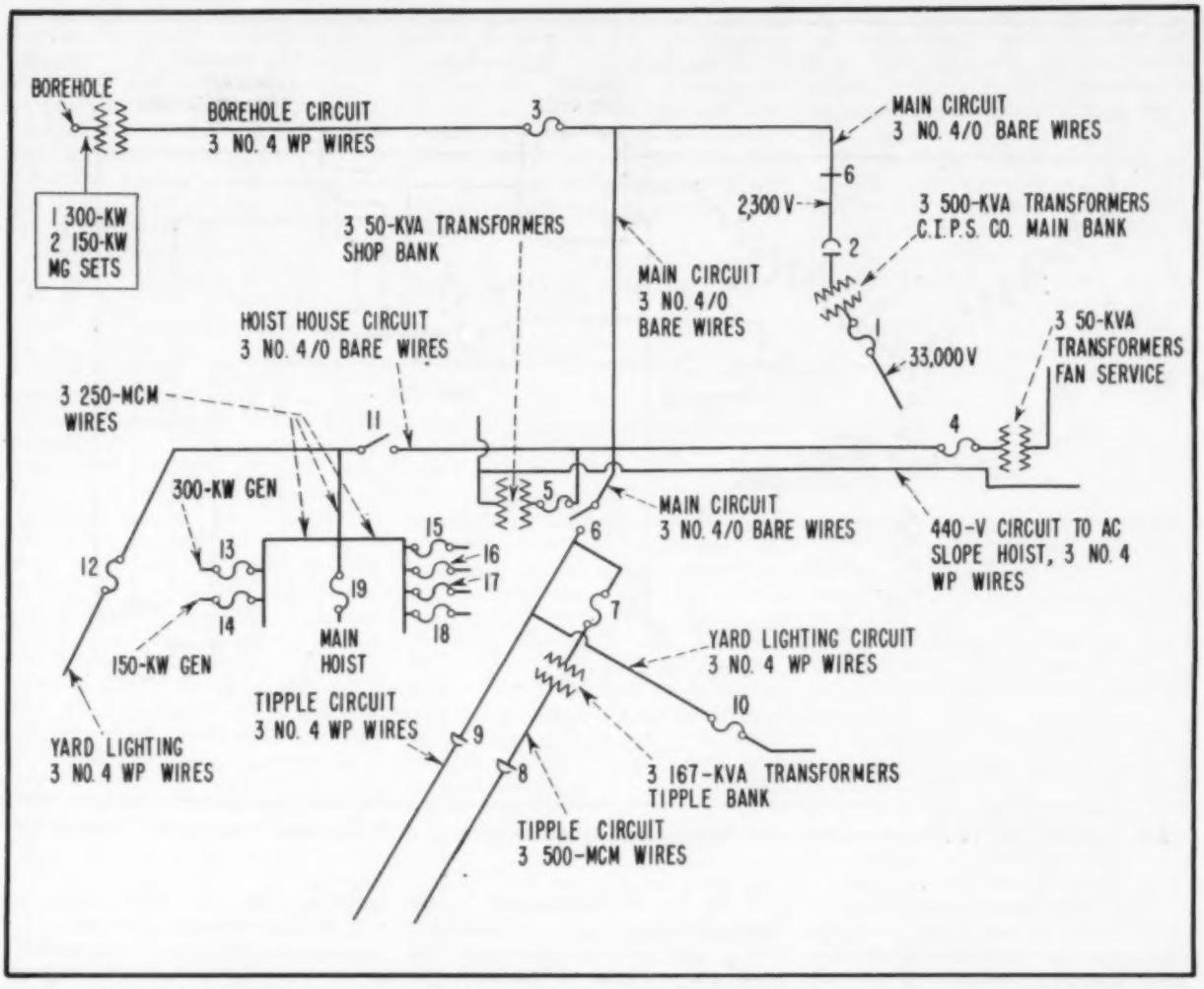
An essential item in good electrical service, therefore, is a record of voltage. Regular checks should be made with portable meters, and under some circumstances recording-type meters may more than pay their way.

Primary Power

Whether to distribute in one or two steps is one question that can arise in setting up or revising primary electrical power facilities. Normally, the one-step system is the one employed, with either 2,300 or 4,160 v as the nominal transmission pressure. The trend is toward 4,160. And as concentration, loads and transmission distances, particularly for cables, increase, 6,000 v may be expected to come into the picture.

Two-step systems are relatively few in coal mining, and where they have been adopted the "super-primary" voltage usually is 13,000.

Three-phase transformers are growing in popularity, though the old-reliable single-phase units are still in the majority. But whether three-phase or three single-phase stations are employed, protection should include lightning arresters, circuit breakers, ground-protective equipment and other control and protective facilities. The two accompanying diagrams show the facilities at two new mines, including control and protective equipment, as well as how the circuits are set up to serve surface facilities in



PROTECTIVE EQUIPMENT IN AC SYSTEM for new mine is shown by numbers: (1) primary fused cutouts; (2) secondary breaker; (3) 100-amp fused cutout with 80-amp links; (4) 50-amp fused cutout, 30-amp links, fan circuit; (5) 50-amp fused cutout, 50-amp links, shop transformers; (6) pole-top switch, 3-pole gang-operated, 7.5-kv, 400-amp, tipple circuits; (7) 200-amp 7.5-kv trip-out fused cutout, 125-amp links, tipple transformer bank; (8) 600-amp OCB, tipple circuit; (9) 400-amp OCB, tipple circuit; 50-amp fused cutout, 2-amp links, yard lights; (10) disconnect switch, 7.5-kv, 400-amp, hoist-house circuit; (11) 50-amp fused cutouts, 2-amp links, yard lights; (12-13) 200-amp fused cutouts, 5,000-v 200-amp links, 300-kw m-g set; (14) 200-amp fused cutouts, 5,000-v 150-amp fuse links, 150-kw m-g set; 15-18 50-amp fused cutouts, 50-amp links, compressors; (19) 200-amp fused cutout, 5,000-v 200-amp fused links, main hoist.

addition to underground. One plan, it will be noted, includes a 1,600-hp diesel emergency generator.

Central Metering—Though the rule is not completely hard-and-fast, it usually is worth a fair investment in extra lines to permit metering of all incoming power at one point.

Power Factor—Without correction power factor at the average coal mine would be 60 to 85%—sometimes less but seldom more. Corrective methods and equipment include:

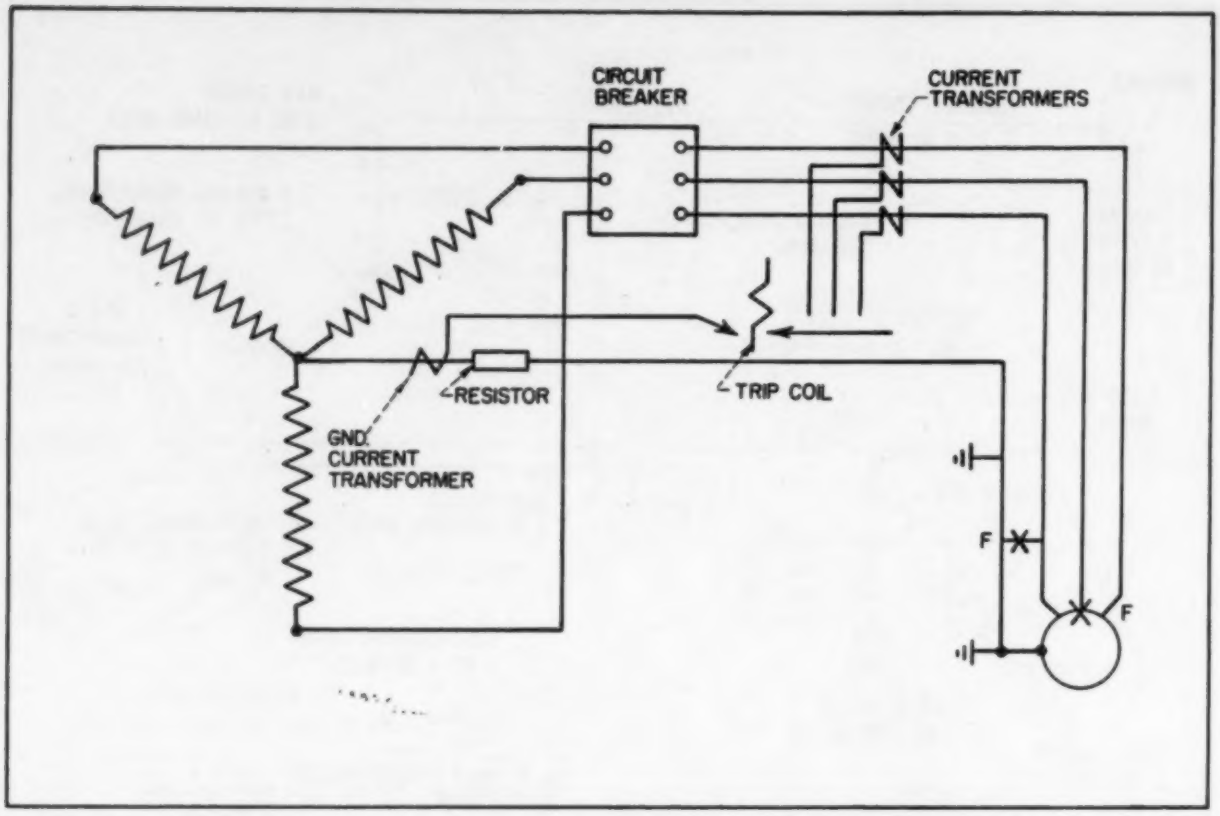
Synchronous motors, 0.8 leading, on m-g sets.

Synchronous motors for equipment, such as pumps, fans and the like, requiring, say, motors of 100 hp or more.

Capacitors to supplement other forms of correction and bring power factor up to 90 to 95%, which normally takes the mine out of the penalty area. Even if power-factor penalties are not included in the rate structure, improvement is warranted to reduce the wattless current in wire, cable and motors. Theoretically, correction should be installed with each induction motor of any size, but a more-practicable system is capacity for a group of motors near the center of such a group. The farthest-back location, and the least preferable as a rule, is the substation.

DISTRIBUTION

Choices in distribution of 2,300 or 4,160 v AC include overhead pole lines to surface substations and facilities, normally bare wire but occasionally weatherproof cable; underground cable systems; and a combination of pole lines and cables. Where openings may be made along outcrops or the cover is not too deep for boreholes, the pole line normally is preferred. Man-and-materials or air shafts back from the main portal are other spots where pole lines may be terminated. If the rule of not over 2,500 ft for transmission of DC is observed, and unless a system can be worked out so that the opening can serve 2,500 ft outby as well as inby, new openings and terminals for the pole lines theoretically would have to be established every half mile. An alternative is a certain amount of underground cable to supplement the pole lines.



AC CIRCUIT PROTECTION by grounding transformer circuit to neutral of Y-connected transformer secondary.

Type SHD cable, rated at up to 15,000 v, is becoming the most popular type for underground service. Each insulated conductor is covered with copper shielding braid to equalize surface stresses and eliminate static discharge—the cause of corona cutting. Grounding conductors, one for each power conductor, are placed in the interstices. A neoprene jacket over all completes the assembly.

Borehole and Shaft Installation—Neoprene-jacketed cable may be used in taking AC down boreholes or shafts, provided, among other things, depth is not too great. Deep shafts or boreholes usually warrant armored cable, which can be supported by the armor wires with no strain on the conductors and, in shafts, is protected against falling material or moving equipment.

With neoprene-jacketed types, the entire cable, if it is short, may be hung from a clamp or basket-weave grip at the top. Longer cables may be clamped to a messenger wire in boreholes. A more frequently used type of suspension is supporting the entire weight of the cable by clamping each conductor to a separate strain insulator.

Preferred procedure in installing cables in boreholes is to pull the cable up through the hole with a wire rope and hoist, truck or bulldozer. Where it is necessary to lower the cable, the reel must be provided with adequate braking facilities. A bulldozer or some other heavy piece of equipment may be employed to control lowering of the entire cable or the final end into the hole. For example of bulldozer use, see *Coal Age*, May, 1954, p 116.

Looping may be used to lower cables into shafts. One end is permanently anchored and the other is lowered by a wire rope. The cable loop in the shaft should be at least as large as the diameter of the cable reel. Items required in this lowering method include a large sheave at the shaft, a pulley system along the ground for controlling lowering, a truck to pull the cable into the shaft, and a bulldozer for retarding when enough cable is in the shaft to pull the remaining section in.

Underground Installation—Where adequate protection and grounding are available, neoprene-jacketed cable may be installed in accordance with the same standards as armored cable. In other words, it may be supported on messenger wires or directly on hangers, both suspended by insulators, or it may be buried. The location may be either the intake airway or the haulage opening, provided, particularly in the latter instance, that proper protection against moving equipment and other hazards is provided. Suspension in regularly traveled openings permits earlier detection of conditions that might lead to trouble, and also makes it easier to take care of trouble if any should be encountered.

PROTECTION

Major items involved in the protection of AC distribution systems, particularly of the cable type, include the following:

Approved-type lightning arresters at the point where the circuit enters the mine, as well as back at the substation if the entrance is some distance from the substation.

Outside switching facilities comprising either a disconnecting switch or a circuit breaker, preferably the latter. The breaker should trip on both phase overcurrent and ground-fault current.

Disconnecting equipment at the bottoms of boreholes, if entrance is by this means, preferably subway-type oil cutouts or oil switches.

Suitable disconnect switches at each branch circuit. These may be the

same as equipment used at borehole entrances. In more-comprehensive systems, where automatic sectionalization may be desirable, circuit breakers with suitable relaying equipment may offer advantages.

Suitable junction boxes and couplers. Plug-in-type couplers should be interlocked so that the key for opening one can be obtained only by opening a switching device ahead.

Grounding—The primary duties of ground wires in high-voltage cable and in surface lines associated with such cable are (1) to operate ground-protective equipment, and (2) to keep equipment connected to the high-voltage circuit at as near ground potential as possible. Ground wires should be metallically connected to equipment frames. They should be continuous, they should be checked from time to time to see that they are continuous, they should be protected against stray DC currents, and they should be checked regularly to see that they are not carrying excessive stray current—on the order of 40 to 50 amp, which normally means a defective DC return. The final touch in good grounding is connecting each item of equipment served by the cable circuit to a driven ground near each unit.

The mine grounding system should be kept separate from the grounds serving the equipment and lightning arresters at the transformer station. This protects men in the mine from the possibility of shock from lightning outside.

Ground Protection—To limit the flow of current in a ground to, say, 25 to 50 amp, and thus the voltage to which a man is subjected in coming in contact with a piece of equipment affected by a short or ground, customary practice is to connect the protective ground to the neutral of a Y-connected transformer secondary through a grounding resistor and current transformer, as shown in the accompanying diagram. The current transformer operates the trip coil to open the breaker. The same effect can be secured with a delta-connected secondary by using a zig-zag transformer to establish a neutral. To permit establishment of a grounded neutral it is recommended that the mine be served by a separate transformer station, even if the ratio is only 1:1. However, by proper switching and relaying, the mine station can serve certain other 3-phase loads.

The accompanying diagram also shows current transfers for detecting ground-fault current and opening the breaker within a few cycles not only to reduce the time men might be exposed to hazards but also reduce equipment and cable damage. Other methods of detecting ground-fault current include the "window" or "doughnut" transformer around the three power wires—but not the ground wires—and the three-phase current transformer with single secondary.

Mine Power Selection

With locomotive or shuttle-car haulage, DC is a necessity for at least part of the mine load. DC also is a simple system and one that is well-known. However, the advantages of AC are numerous and substantial, and therefore, even if DC is retained for haulage, warrant careful consideration for other mine operations. In a dual system, standard conversion or step-down equipment may be used for both services or, as an example, where it is desired to have shuttle cars dump to a belt system, the primary system can be AC with small metallic-type rectifiers (selenium, germanium, silicon, etc.) for serving the shuttle cars.

AC advantages include the following:

Motor cost averages two-fifths the cost of DC motors.

Cost of 220-v AC control is about the same as DC; 440-v is less.

Portable AC substations are less than one-third the cost of DC conversion equipment.

AC equipment maintenance is simpler.

AC is more versatile. Therefore, it is easier to handle a variety of loads. For a small isolated unit, as an example, AC equipment includes a small combination substation and motor starter.

With AC, on the other hand, reactance and power factor must be taken into account along with the usual resistance and load current. Voltage drop during the starting period must be kept to not over 15% to insure contactor operation. With DC, the maximum drop is 20%. The speed of AC motors is not materially affected by changes in voltage—within reasonable limits—but the torque output is affected more than with DC motors because with AC it varies as the square of the applied voltage.

Voltage—As machine horsepower increases, the burden on trailing cables with 220- or 275-v power increases. In many areas, these are the limits for voltage at the face. There are indications, however, that relief is in sight, though it still may come rather slowly. As an example, the new Indiana mine law permits up to 680v at the face.

Where it is permitted, going to voltages higher than 220 or 275 should receive the most earnest consideration. With the same-size conductor and the same distance, twice the load can be handled with 440-v power compared to 220, for example. Conversely, with the same conductor size and load, power can be transmitted twice as far with the same voltage drop and losses.

DC Service

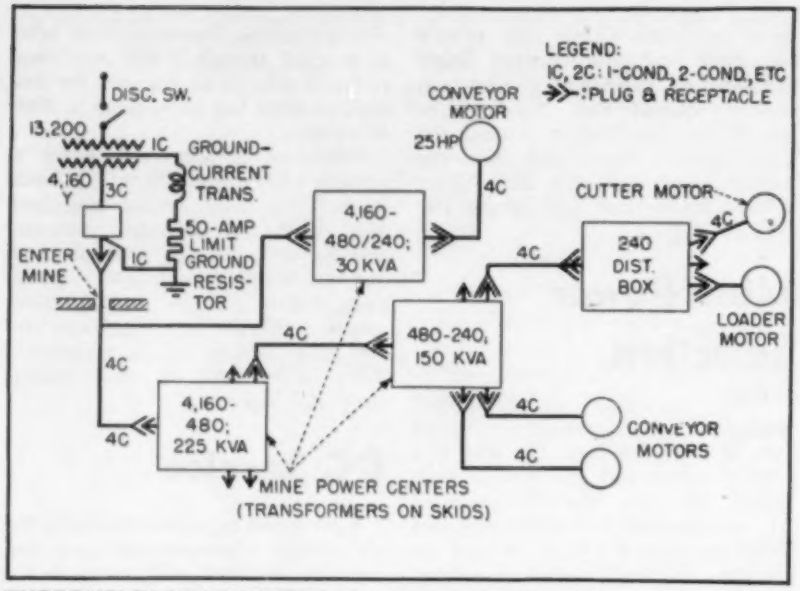
Conversion equipment includes the old-reliable converters and m-g sets, but the standard unit today is the mercury-arc rectifier, including the glass-bulb type. A few metallic rectifiers of the selenium type are in service and units based on germanium, silicon and other metals are under consideration.

For the maximum in convenience and efficiency, the trend is toward portable conversion units. Such units also may be placed in permanent locations—to serve main-line haulage, for example. Or stationary types may be employed at some saving in cost.

Portability facilitates keeping transmission distances short. However, if the cover is shallow, some mines have felt that the lower cost of pole lines and surface facilities, even when offset by the cost of boreholes, warranted keeping conversion equipment or the surface, even with 275 v as the nominal voltage. With 550 v, the reduction in number of moves otherwise necessary is an added reason for considering keeping conversion equipment outside.

Heavy locomotives bring up the problem not only of placement and capacity of substations but also the effect on the remainder of the system as the locomotive passes a given point. To reduce disturbance in face operation as a result of locomotive operation, substations may be equipped with automatic load distributors.

The Inverted Trolley—For locomotive operation, a newcomer in service is the inverted trolley (*Coal Age*, October, 1952, p 87). As the name implies, the trolley is placed on top of inverted hangers, and the locomotives receive power through sliding shoes pulled by cables. Trolley poles and their cost and hazards are eliminated, including backpoling. There is better electrical contact with the wire, less wear on wire and collectors, and greater convenience with cable-reel



THREE-VOLTAGE AC SYSTEM, showing outside substation, ground protection and mining equipment served.

units, since there is no need to change from pole to nip.

TRANSMISSION LIMITS

The maximum distance DC can be transmitted from the substation depends on a number of factors, and must be calculated for each individual operation. Balancing everything, the distance usually should not be over 1,000 to 2,500 ft to keep 250 to 275 v at the motor terminals. Even with the maximum in feeder capacity it is difficult to maintain adequate voltage, let alone rated, for 250-v motors at distances much over 4,000 ft. Incidentally in increasing feeder capacity, it is better to use a number of smaller cables than one large one because the current-carrying capacity is greater. At 30C ambient temperature, 45-deg rise, for example, approximate ratings are: 500,000 cir. mils, 800 amp; 1,000,000 cir. mils, 1,230 amp; 1,500,000 cir. mils, 1,550 amp.

One possible answer to the problem of keeping substation moves down while keeping voltage up in the three-wire, or Edison, system (*Coal Age*, July, 1947, p 86). Requirements are: (1) two generating units in the same substation; (2) two widely separated load centers fed from a junction point several thousand feet from the substation; and (3) a high load factor. If these requirements can be met, a distribution voltage of double load voltage is attained and substantial savings in copper and I^2R losses can be achieved—in 250-v service, for example, up to 70% in voltage drop and 30% in energy losses.

SECTIONALIZATION

Safety, quick isolation of fault areas, and quick replacement of damaged facilities are among the benefits of sectionalization. The latter applies particularly to the growing custom of using short lengths of cable with push-pull connectors in distribution of power at the face. Connector design is such that power is removed before the circuit is opened.

Recommended sectionalizing practice may be summarized as follows:

1. Provide in every instance sufficient capacity in the feeder and return so that the most remote dead short will open the overcurrent protective device, usually an automatic reclosing circuit breaker.

2. Install an overcurrent protective device in the circuit between each two substations at a point where resistance both ways is equal. If enough copper is used so that a ground at any point will open the protective devices at both substations, no intermediate protection is necessary. A section insulator, or "dead block," may be used between substations if they need not be paralleled.

3. Insert a disconnecting switch or protective device at intervals of not over 1,500 ft in all power lines.

4. Install an overcurrent-protective device in each circuit leaving a substation—fuses, or manual or automatic-reclosing circuit breakers. Circuit breakers should have trip-free operating mechanisms. The exception is where a substation feeds only one haulage unit, in which case only one station breaker is required.

5. Place an overcurrent protective device at each branch circuit.

6. Protect each circuit feeding a local section or territory with an overcurrent device.

7. Install overcurrent protection at the supply end of each circuit to pumps or other fixed loads.

8. Install switches to cut power off unimportant and infrequently used branch or stub circuits.

9. Protect each mining setup with an overcurrent device.

10. Keep overcurrent circuit-breaker settings or fuse ratings as low as practical for good operation. Specific settings are listed in a discussion of the subject in *Coal Age*, November, 1953, p 86. How to calculate load division as a guide to choosing breaker settings is detailed in *Coal Age*, August, 1955, p 55.

11. Cut power off all idle territories during non-operating times. If it is necessary to run a pump or some other one unit, special overload protection no greater than needed should be provided.

GROUND PROTECTION

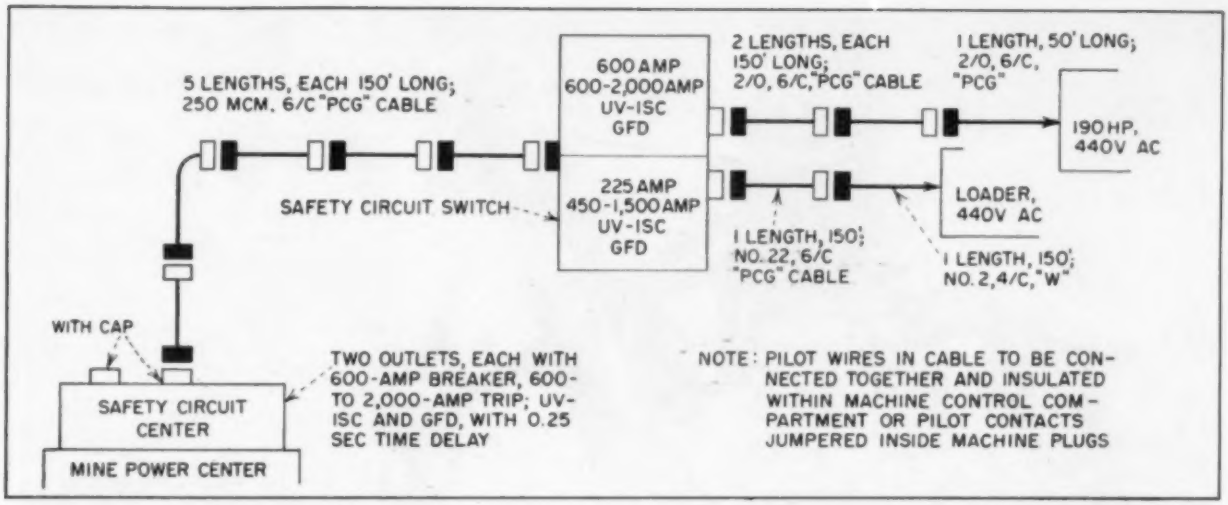
The solid wire from machine frame to ground provides protection to men from short circuits—under most conditions—but no protection to the machine. Thus, some other provision is necessary. The original unit, still widely used, was the fuse, either in the junction or distribution box or in the trailing-cable nip. A major disadvantage is that a ground fault of low intensity, say 100 amp, is not sufficient to blow a fuse—or operate a circuit breaker—rated or set at 200 amp.

The best answer to this latter condition is a three-pole circuit breaker, with one pole in the grounding circuit equipped with a 5- or 10-amp current-limiting relay. A low-intensity fault will trip the breaker as a signal for corrective measures, while a high-intensity fault will be cut off before severe equipment damage occurs.

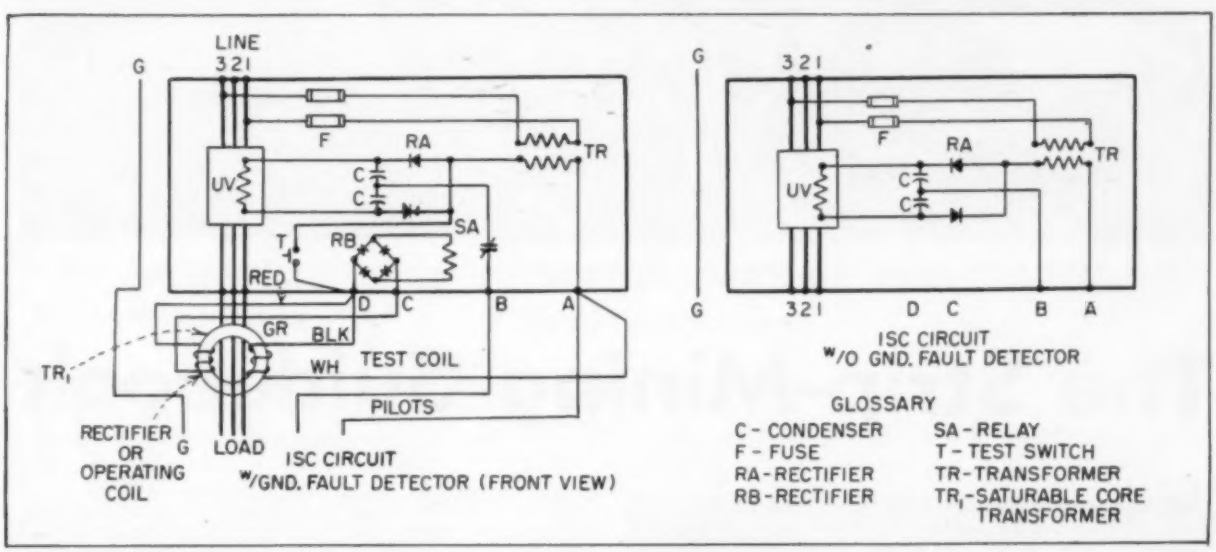
Proposed alternatives, particularly for such mobile units as shuttle cars, include the polarized relay, the polarized short-circuiting device and certain electronic devices (*Coal Age*, February, 1955, p 84).

AC Service

The inherent hazards of oil-filled transformers make non-flammable coolants a must where liquid types are employed. But even when the coolant will not burn, it still weighs



MODERN AC SETUP designed for higher voltages provides protection for men and equipment and permits ready circuit extension by sectionalized cable.



CONTROL CIRCUIT for modern AC system with and without ground-fault detector.

and thus makes moving transformers more of a job, especially in thin coal. The dry-type unit has commanded increasing favor as a result. A variation also finding greater use is the sealed nitrogen-filled transformer. As an example of the saving in moving time, one mine can take a three-unit 150-kva sealed-type station 1,000 to 1,200 ft in 3- to 4-ft coal in ½ to 1 man-shifts, compared to 10 man-shifts for conventional oil-filled equipment.

Capacitors should be included in or with AC power centers. They reduce voltage loss, cut conductor and motor heating, and permit longer trailing cables.

DISTRIBUTION

The opportunity of using 440 v or higher at the face (up to 680 v in Indiana) considerably eases the problem of face distribution with AC. Where the limit is 220 (nominal), trailing-cable limitations make it impractical to transmit AC more than a few hundred feet. This requires the use of an intermediate voltage or frequent moves. The latter are facilitated in low coal by skid mounts and dry-type or sealed transformers to reduce weight.

Where an intermediate voltage is employed, it normally would be 440 (nominal), though it could be higher. How one three-voltage system is set up (*Coal Age*, September, 1955, p 91) is shown in the accompanying diagram. Among other things, the diagram illustrates the use of the grounded neutral system for protecting men and equipment summarized in the discussion of "Primary Power" earlier in this section.

Basic elements in a modern AC power-distribution setup underground are shown in the accompanying schematic drawings. It involves among other things an "intrinsically safe control circuit" using pilot wires in the cables to open the breakers and permit cables to be connected or disconnected between lengths or to power centers, circuit centers and junction boxes with no danger of incendiary arc. Undervoltage protection is provided at the same time. Ground-fault detection may also be provided by means of a detector coil around the power leads, a bridge rectifier and a sensitive relay (*Coal Age*, August, 1944, p 88). A pushbutton is provided for testing the circuit.

TODAY'S STRIP MINE is geared to maximum production from matched units working in a well-planned operation.

The Strip-Mining Guidebook

CAPACITY AND FLEXIBILITY are combined in new draglines mounted on two crawlers for easy maneuvering.

MATCHED CAPACITY between the coal-loading shovel and trucks provides smooth loading and hauling cycle.

Where to Find It in . . .

The Strip-Mining Guidebook

Preparing for Operation

The first job in planning a strip mine is to find out how much coal is available and where it is. There are a number of ways of doing this and the following questions should be constantly in mind as preparation is made for operation:

1. Who owns the surface and mineral rights in the area being considered?

2. What does the land look like—how does it lay?

3. What will be required to get the coal out once a suitable area is blocked out and prospected?

4. How does the coal analyze?

5. What are the seam conditions?

6. Are there any restrictions on the use of the land? What about restoration of the surface after stripping is completed? Is there the danger of slides damaging adjoining land? Are there pollution problems to be considered?

7. What will the mining costs be?

8. How much will the coal sell for?

9. What kind of material covers the coal?

AERIAL SURVEYING

Good maps are the foundation for gathering and assembling information before starting mining. An aerial survey from which accurate maps of all types can be made is the latest tool studying for prospective stripping sites. And the cost is only about half that of the ground survey. Because of the multiple uses for aerial maps and photos, they have become more and more popular with stripping engineers and operators.

Aerial mapping also is more flexible than ground surveys and the same set of aerial negatives can be used for three jobs. They can be used for stereoscopic study of the land under consideration. They can be grouped into a mosaic which makes a good reconnaissance map. Then, when the area of interest is defined, a contour map can be made from the aerial photographic base. The speed with which these maps can be made is a major advantage.

An average topographic map can be made up in one-half to one-fifth the time needed for ground surveys at a sizable savings in cost and with no sacrifice of accuracy. With an aerial topographic map, an engineer can estimate coal acreage, plot crop lines, spot boreholes, determine and locate spoil areas, lay out haulage roads, compute overburden ratios and plot property lines.

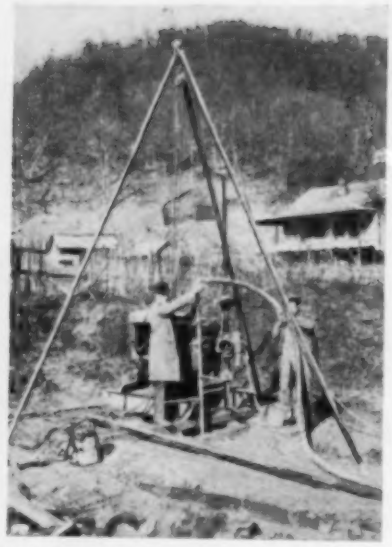
A minimum of surface or ground control is needed in aerial topographic mapping. In some cases existing control may be entirely satisfactory. In others, it may be necessary to establish vertical control points for each photo and several horizontal control points along each flight strip.

When it is not practicable or desirable to have an aerial survey made, a ground survey may be required, particularly if there has been no previous mining in the area. The extent of the survey will depend on the lay of the land and how much information is already available, such as, topographic maps and geologic bulletins. If deep mining was done in the area, mine maps will provide a valuable source of information and will reveal a great deal about the nature of the coal. First, they will show how much, if any, coal is left between mine workings and the outcrop. Seam characteristics, including dip, thickness, unusual conditions and so on probably will be shown on the maps.

DRILLING

The next step after mapping is to assemble as much information as possible about the coal seam and mining conditions. Drilling is the most satisfactory method of prospecting coal for

AERIAL SURVEYS provide a base from which accurate low-cost maps of all types can be made. Cost is less than ground survey and requires less time.



CORE DRILLING of prospective strip land assures accurate record of strata.

MODERN PROSPECTING is done with bulldozers that can make an outcrop opening in a minimum of time and at a low cost.

full and accurate information. This can be done either by churn or diamond equipment. Diamond drilling provides a core section of the overlying rocks and the coal, and therefore yields very valuable information. A churn drill in the hands of a skillful operator also can provide accurate data but is no proof that it is accurate. A coal core, on the other hand, can be examined visually and half of it sent to the laboratory for complete analysis. The other half can be kept for reference.

In any drilling program, sufficient holes should be drilled to get an accurate picture of the coal bed. The drilling results should be plotted on the property map along with other key data. Isothickness lines should then be added to the map.

If the coal bed outcrops, prospecting should be done at regular intervals along the outcrop. The modern tool for this job is the bulldozer. Once the bulldozer is on the outcrop, it can make an opening faster and more economically than by hand methods. Outcrop openings can yield other useful information on the type and nature of the rock covering the coal and how much outcrop coal must be removed before merchantable coal is reached.

As prospecting information is accumulated, it should be put on a prospecting and property map developed from a topographic map base. Such a map will give a "bird's eye" view of the potential of the proposed stripping area. As the picture on the prospecting map takes shape, decisions can be made as to where more prospecting is needed and how much.

The possibility of having a second valuable mineral present in the strip pit should be carefully checked. Some coal companies have added significantly to income by recovering at little or no extra cost fireclay under the coal and shale over it. (*Coal Age*, June, 1955, p 72). These profit makers may be the difference between a marginal operation and a profitable one.

PLANT LAYOUT

If a new preparation plant must be built, the first job is to pick a site for it. Choice of a location is governed by access to rail facilities, suitable building space and nearness to the coal to be mined. Where possible, the plant should be centrally located so haulage distances will be as short as possible.

After the plant site is selected, the point to attack the coal seam should be selected. Then a permanent haulage link should be laid out to connect the preparation plant with the pit. A preliminary road layout can be made on a topographic map, along with estimates of the earthwork involved in building it. The field work then will consist of marking off the road route and making any minor adjustments.

In arriving at a permanent road layout, it should be remembered that good alignment and grades will pay off in faster haulage and lower truck maintenance. A solid, well-drained roadbed should be standard practice in all road design. Trucks should be able to travel at top speed whether loaded or empty, and drivers should be able to see clearly on all curves.

The mine layout will be governed

HIGH CAPACITY rotary drills come in where volumes of cover are moved.

MOBILITY and fast drilling are featured in smaller truck-mounted unit.

ELECTRIC MEASURING DEVICE in drill cab records hole depth accurately.

by a combination of factors: type and contour of the overburden, coal thickness, coal quality and the quantity available. If the coal lies below drainage, a box cut will have to be made to gain access to it. If the coal is to be mined by following the contour or outcrop, a considerable sum of money may have to be spent to build roads to the coal level. If it is not desirable or feasible to haul coal downhill to the preparation plant, a bin, feeder and conveyor setup will be needed at the dumping point to link it and the cleaning plant. The final selection of method will have to be made after a careful analysis and weighing of all the factors.

SELECTING EQUIPMENT

Closely linked to the mine layout is the selection of equipment for all phases of the operation. Natural conditions along with economic factors will largely determine the type and size of equipment to be used. The key question will be how many cubic yards of waste material can be economically handled to recover a ton of coal. Today there is no simple or magic formula that can be applied to determine the economic stripping limit. A realistic set of estimated cost figures is the best guide. When the limit is determined, equipment capable of working to the limit can be considered.

To help in the selection of stripping equipment, it is wise to draw profiles of the proposed stripping area along with equipment dimensions and ranges. This type of diagram will show how wide the pit can be made, what the spoil bank will look like and how

SIDEWALL DRILL is an effective unit where the cover is not too thick. Units are either mounted on truck bed or are self-propelled on wheels.

each type of equipment can be used most efficiently. Some of the factors affecting the selection of key stripping units will be the tonnage of coal desired per shift, surface features, available spoil area and type of overburden to be handled.

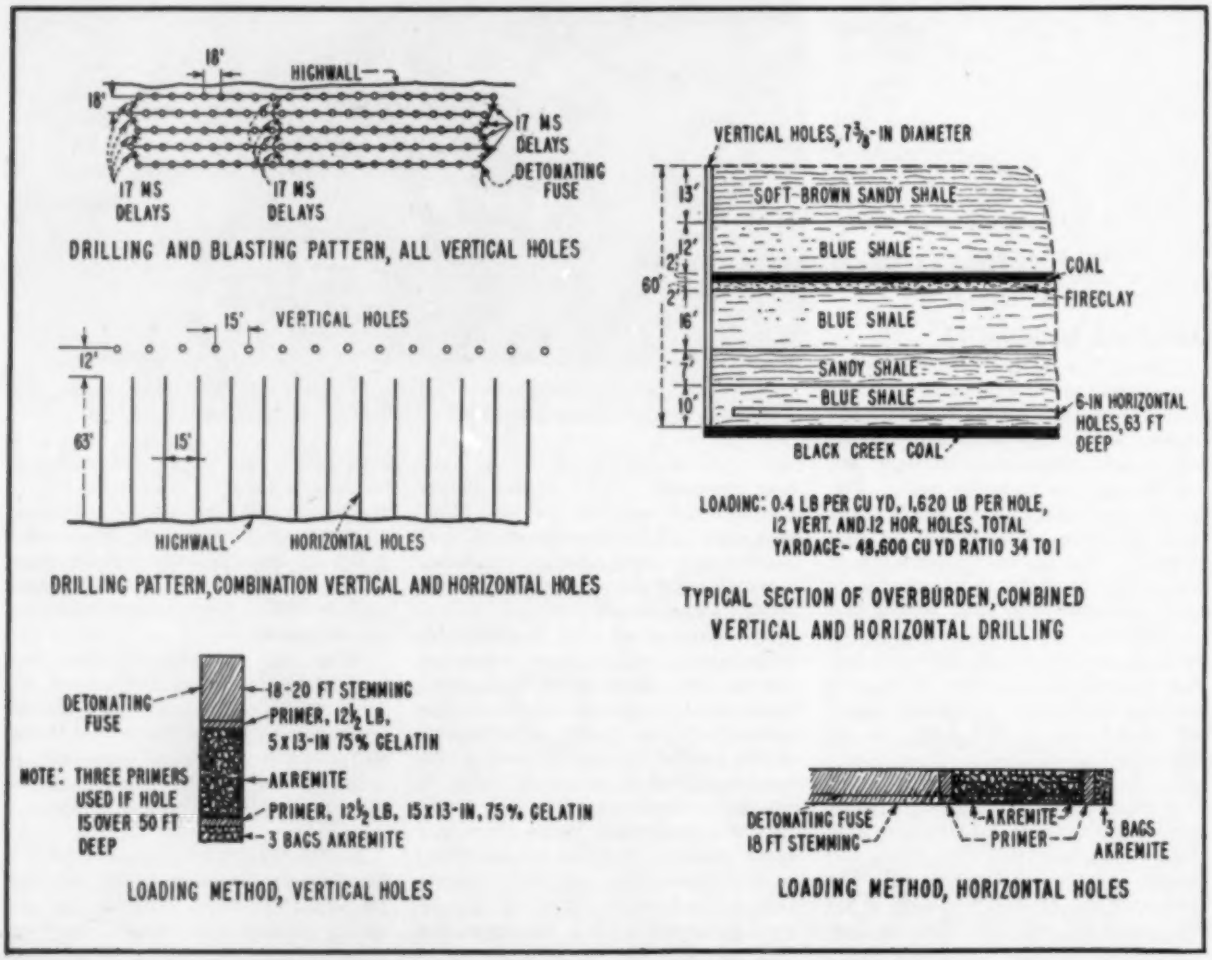
The reserves of coal available for stripping also will play an important role in the selection of equipment. There must be enough coal owned or under lease to permit amortization of the capital investment over a reasonable period of time. It could be unwise to develop a mine with small-capacity equipment when there are ample reserves that can be recovered more economically with high-capacity units. Contrariwise, it would not be good judgment to buy big expensive machines if there are not sufficient reserves to set up a reasonable depreciation rate. Before making a decision on the type of equipment, it is sound policy to have a series of meetings between engineering, operating and manufacturers' representatives to consolidate ideas.

After the stripping machine has been selected, other units, such as, drills, coal shovels and trucks, should be chosen with capacity geared to the stripping unit. Matched equipment is necessary for smooth, efficient operation and therefore low-cost mining.

Radio—Where mining plans call for the various machines to be working far apart or in more than one pit, strong consideration should be given

SHORT-DELAY BLASTING contributes to better fragmentation of overburden and decreases shock and vibration.

MAKE-YOUR-OWN EXPLOSIVE has reduced explosives costs, improved fragmentation and stripping efficiency.



TODAY'S DRILLING AND SHOOTING PATTERNS include vertical and horizontal holes or a combination of them to get the best fragmentation for easier stripping. Careful study is required before selecting a pattern.

to installing a radio communication system. Money spent on the radio setup frequently can be repaid in better supervision and less equipment down time. For example, time lost by equipment in the pit can be substantially reduced because stripping units can report trouble immediately. Therefore repair crews and facilities can be called to the scene promptly. If the job requires parts or materials not on hand, they can be ordered from the warehouse in a matter of seconds merely by picking up the microphone and calling. If an emergency order for a part must be sent to the factory, word can be sent to the mine office and immediately relayed by phone to the factory. Frequently the part can be on the way to the mine by plane in less time than it would take to drive from the pit to the office.

Another important benefit of radio communication grows out of the fact that supervisory efficiency can be improved considerably by reducing the time needed to cover the ground to check operations. With radio, much of the routine of checking on the progress of stripping and pit conditions can be done by calling the pit, thus reducing supervisory driving to a minimum and leaving more time for planning.

Overburden Preparation

The goal in overburden preparation is to break up the material as fine as necessay to permit easy handling by the stripping unit. The ideal condition would be to have the overburden broken down into gravel-size pieces to permit low-cost handling with smaller equipment than required for moving larger-size material or boulders. However, since the cost fo drilling and shooting, including labor, to pulverize the material normally would be prohibitive, fragmentation must be looked at from the standpoint of over-all cost.

DRILLING ROCK

Maximum fragmentation with a minimum of labor, equipment and blasting can be achieved with high-capacity drills sinking holes in a good pattern, plus the proper breaking medium properly applied and detonated. An increasingly popular machine for drilling overburden at large-capacity mines with thick cover is the large rotary dry-type drill. Capable of drilling a 12-in hole, development of these drills reflected industry demand for a machine that would function more efficiently than the churn drill in thick, tough rock. This became much more important in recent years as more power and capacity was packed into stripping units and pressure for keeping them working at full capacity became greater. In a typical installation at a large stripping operation, a three-man crew with one large rotary dry-type unit drills 1,000 ft of 10⅜-in hole and shoots better than 30,000 cu yd overburden in a shift, permitting a dragline to move better than 1,000,000 cu yd in a month (*Coal Age*, March, 1953, p 80).

Big drill advantages also include an opportunity to use less-dense, lower-cost blasting mediums. Others are better fragmentation; less explosives per cubic yard of material broken; clean, smooth holes; and excellent stemming from drill cuttings.

The success of the high-capacity drill created a demand for the same type of drill in a lighter, smaller, more mobile and less expensive package for use at smaller operations. To meet this demand, a series of truck- or crawler-mounted drills have been designed and built for the smaller operator whose output is less than 2,000 tpd. Capable of penetrating rock at the same speed as the big units, the smaller drills are available in a variety of sizes to fit the needs of the smaller producer.

In recent years there has been a distinct trend to vertical drilling as overburden has become thicker and harder. There are several reasons for this: (1) a better chance for getting better distribution of explosives throughout the overburden; (2) more opportunity for getting explosives into hard layers where they are needed most, though some two-level horizontal drilling is achieving the same goal; and (3) reduced drilling footage where cap rock or other hard layers must be broken.

The horizontal sidewall drill remains a favorite for special applications and where the cover is comparatively thin. In some cases they are used effectively for two-level drilling in thicker cover. Special adjustable-level hydraulically powered sidewall units can be used effectively to drill near a strata whose position over the coal varies up and down. They also have the advantage of easy leveling in an uneven pit. Tractor-mounted percussion units for special conditions, such as a thin, hard layer of rock between two coal seams should not be overlooked in seeking low-cost bank preparation.

BREAKING ROCK

Efficient overburden preparation boils down to getting the right charge of explosive in the right place. A careful study of the overburden and constant checking of field results is the answer to effective rock breaking. Sometimes a particular type of rock can be broken best with a heavy charge in large-diameter holes spaced far apart. It other cases, smaller charges in smaller holes spaced closer together will provide better breakage. A combination of vertical and horizontal holes produces the best results at other times.

In selecting the right explosive for a job, engineers and operators must consider the physical characteristics of the bank, its height, the material, drilling equipment available, digging equipment to be used and then select the right product to give maximum fragmentation. The drilling pattern will depend mainly on the foregoing factors.

Usually shale overburden can be blasted successfully with a single row of horizontal holes if they are large enough to permit the proper loading ratio. A single row of holes should be drilled so that the resistance of the material above the holes will roughly equal the resistance of the material between. As banks increase in height, it becomes necessary to increase the size of the hole, since holes drilled close together tend to shear horizontally rather than exert force upward to produce the desired fragmentation. For deeper cover it is possible to use high and low horizontal holes or to combine horizontal holes with verticals.

Where overburden is over 50 ft, vertical drilling generally is considered best. Two-level horizontal is usually too costly and single-level is inadequate.

Aside from varying the drilling pattern to meet the needs of individual pits, the method of distributing the charge in the hole can affect the blasting efficiency. With some types of rock, full-column loading produces the best results. With others, deck or divided loading gives better fragmentation.

Good records should be kept for all blasts, including depth and spacing of holes, quantity and distribution of explosives per hole, type and thickness of overburden, feet of drilling, and cubic yard of material broken each day. When a satisfactory plan for shooting is worked out it should be adhered to until conditions change. The goal in blasting is to get maximum fragmentation at minimum cost and thereby permit the stripping unit to move more material with less effort.

One company has developed an

STRIPPING THICK COVER in anthracite is a job for draglines that have a wide working range and can dig deep.

SPECIALLY DESIGNED SHOVEL for simultaneous stripping of two seams is typical of today's equipment.

Stripping Equipment Geared to Mining Conditions

SHOVEL AND BULLDOZER are effective in lighter cover. Shovel moves coarse rock while dozer pushes fines.

VERSATILE TRACTOR-SCRAPERS can cut down 30 to 35 ft of cover and haul it several hundred feet.

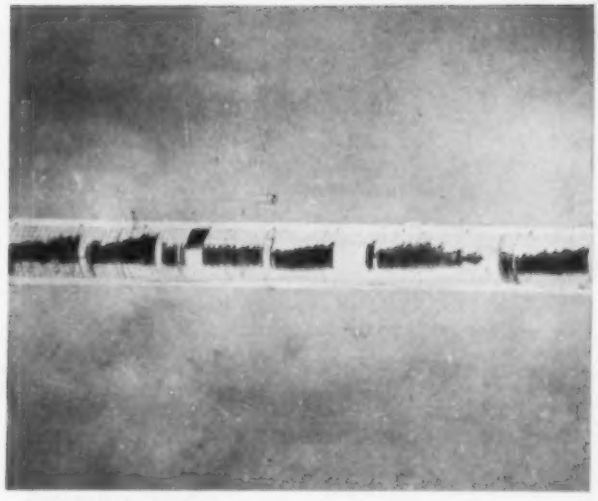
electric device that automatically records the depth of the blasthole as it is drilled. When a change of strata or a significant change in hardness occurs in the rock, it is reflected in a variation in drilling pressure. The drill operator notes depth on the indicator, as well as pressure, and records both in a log book. The record for each hole is given to the blaster to serve as a guide in charging the holes (*Coal Age*, May, 1955, p 122). The operator can look at the hole log, tell how tough the rock is and then how much explosives will have to be used to get the best results.

Delay Shooting – Delay shooting usually will permit explosives to do a better job. At many mines millisecond delays have been used successfully to get better fragmentation and at the same time reduce concussion in the surrounding area. Reduction of vibration is especially important where stripping is being done near populated areas. The progressive relief possible with delays also permit the explosives to perform more efficiently.

As overburden becomes thicker, the problem of vibration and shock become greater because the thicker rock requires more explosives. In recent years, the MS-delay connector has become a valuable tool in reducing vibration—in many instances to about 25% of that with the usual shot.

The MS connector essentially is a piece of detonating fuse with a millisecond delay built into the center. Benefits from the connectors include setting off a greater number of holes per shot with less vibration, and elimination of the hazard involved in loading a cased hole where it is necessary to charge from the drilling machine through the casing and then pull the casing up over the shunted cap wires. During this operation there is always the hazard of stray currents or a short circuit that might ground through a damaged cap wire, setting off the charge. With detonating fuse, no cap is used until this operation is completed and the machine has moved away (*Coal Age*, June, 1951, p 86).

LOAD INDICATOR in shovel operator's cab shows when dipper is full and tells him when unit is being overloaded.



SWING CHART like this records degree of swing and the number of swings per shift of stripping units.

A further advantage includes a 15% speed-up in the detonation of the explosive with a reduction in the requirements. Fragmentation is as good and probably better with the reduced charge. Digging into misfires is not likely to result in an accidental explosion since caps are not used in the charges.

Blasting mediums in use today include various types of high explosives; liquid oxygen; and newly developed lower-cost blasting agents, such as, Akremite (*Coal Age*, May, 1955, p 70). The characteristics of the rock and the drilling and stripping equipment control the type and quantity of the breaking medium needed and therefore no hard and fast rule can be made. In general, a dragline will require finer broken rock than a shovel, and the larger the stripping unit, the larger the size of material that can be handled economically with it, within limits.

Stripping

After the best drilling and shooting patterns have been set up, the right use of equipment for handling the overburden must be considered. The goal in uncovering coal is to have the stripping unit remove as much material as possible in a shift. However, output alone is not the only factor to be considered in selecting the stripping unit. It must be suited for the job.

Bulldozer Stripping—As a result of more speed and power being built into today's bulldozers, they are being used successfully as stripping units. Working in pairs or in conjunction with other equipment, they are effective in moving overburden that normally requires little or no shooting.

Latest models available to the industry include single-engine units powered by engines delivering 230 hp and twin-engined models powered by two 190-hp diesels. Drawbar pull in the range of 60,000 lb or better is a feature of the new high-powered tractors. Modern tractors are available with either torque converters or direct drive.

Where stripping is assigned to bulldozers alone, a minimum of two should work together. For efficient material handling, an average of not more than 35 ft of cover should be moved and the terrain should be gently rolling or hilly to permit easier movement of overburden. Pushing should be 90 deg with the outcrop after the initial cut is made along the outcrop and the bulldozers should work together, one following the other and slightly overlapping the path of the leading unit.

After the pit is filled sufficiently, the dozers should start pushing to the main spoil area away from the highwall. As succeeding cuts are made and the highwall gets steeper, it will be necessary for the dozers to rehandle as much as 20% of the material. To establish the highwall, the bulldozers should cut parallel to the outcrop and dig down to the coal. If hard material is met, it should be drilled and shot fine enough so that the bulldozers can move it easily.

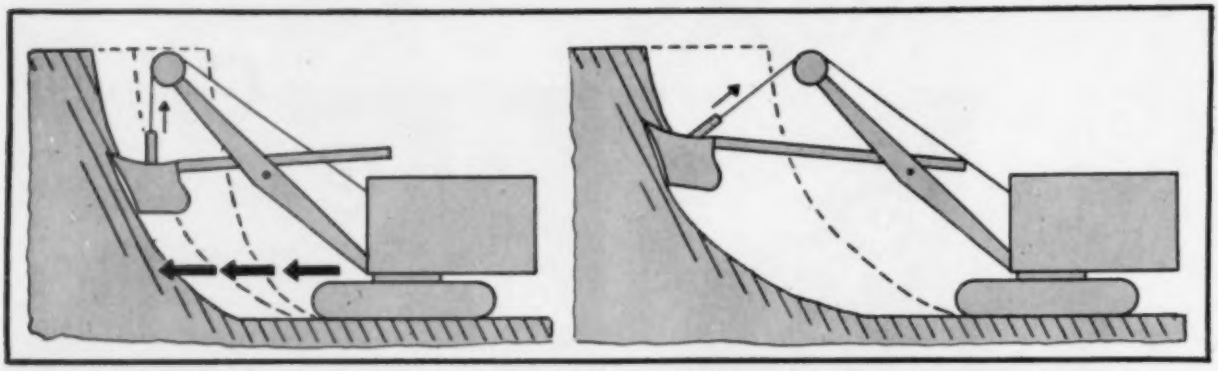
Another possible combination for stripping up to 35 ft of softer material is the small shovel and the bulldozer. With this type of setup the bulldozer works across the outcrop and takes off 10 to 12 ft of loose material—

RADIO COMMUNICATION is a big booster toward efficient performance.

sometimes up to 20 ft (*Coal Age*, January, 1954, p 82). The shovel is used to remove the more solid material down to the top of the coal.

After a sufficient area of coal is uncovered, the shovel can double as a coal-loading unit while the bulldozer continues to remove the top layer of cover or performs utility or cleanup work. The shovel-bulldozer setup is not designed for high output but can be used effectively where cover is relatively soft and a large capital expenditure is not feasible.

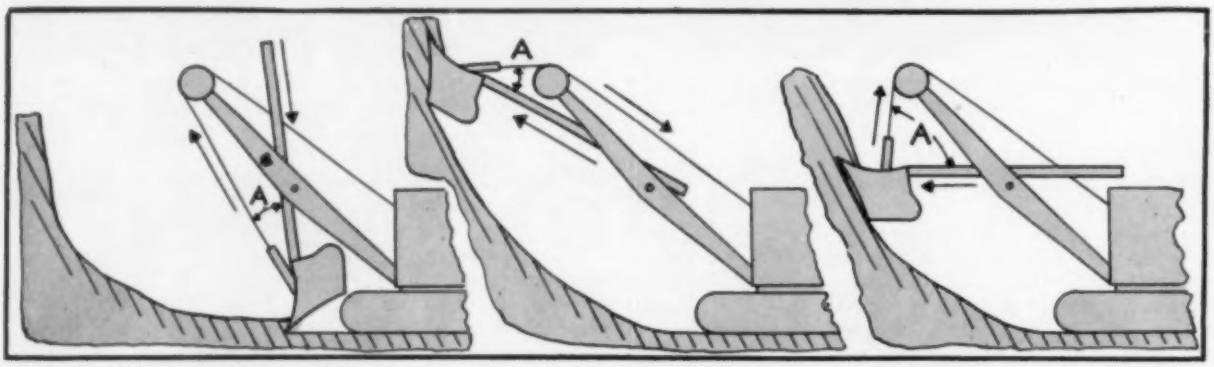
Scraper Stripping—It is possible that conditions may change after a stripping unit has been purchased and it may be desirable to go to a higher bank. However, the available shovel or dragline may not be able to handle the overburden in one pass. Conse-



EFFICIENT METHOD — Move up. Keep close to face but not too close to beat-up track with dipper.

INEFFICIENT METHOD — Reaching for the work instead of moving up.

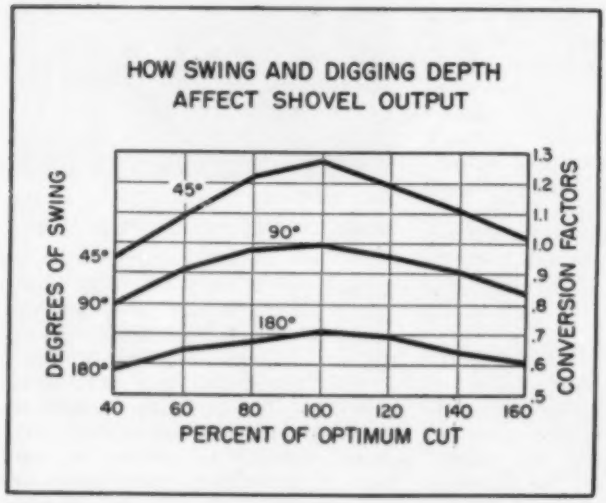
Tips On Better Shovel Operation



BAD . . . little or no hoisting force in line with cut — crowd action opposes hoist action.

BAD . . . very little hoist power available for cutting—hoist action opposes crowd action, over-strains dipper, sticks and shipper shaft.

GOOD . . . hoist and crowd actions work together resulting in faster action.



Effect of Depth of Cut and Angle of Swing on Power Shovel Output

Depth of cut in % of optimum	Angle of swing in degrees						
	45°	60°	75°	90°	120°	150°	180°
40	.93	.89	.85	.80	.72	.65	.59
60	1.10	1.03	.96	.91	.81	.73	.66
80	1.22	1.12	1.04	.98	.86	.77	.69
100	1.26	1.16	1.07	1.00	.88	.79	.71
120	1.20	1.11	1.03	.97	.86	.77	.70
140	1.12	1.04	.97	.91	.81	.73	.66
160	1.03	.96	.90	.85	.75	.67	.62

Conversion factors when applied to the output of 90-deg swing and optimum depth of cut, will give the output at other angles of swing or depth of cut for dragline and shovels.

quently, rehandling or two passes are needed. Or the unforeseen problem of a shortage of spoil area may develop and partial haulage may be necessary. Under these conditions the high-speed rubber-tired tractor-scraper has gained acceptance as an efficient auxiliary machine to move the top portion. Once loaded, the unit can haul spoil several hundred feet at little added cost. If the overburden is compacted, it is good practice to supplement the scraper units with a rooter that can be taken over the ground ahead of the scrapers to break up the ground for easier loading.

Tractor-scraper units can be used to make an opening cut and working bench for a dragline (*Coal Age*, June, 1949, p 94), or remove up to 35 ft of overburden (*Coal Age*, August, 1953,

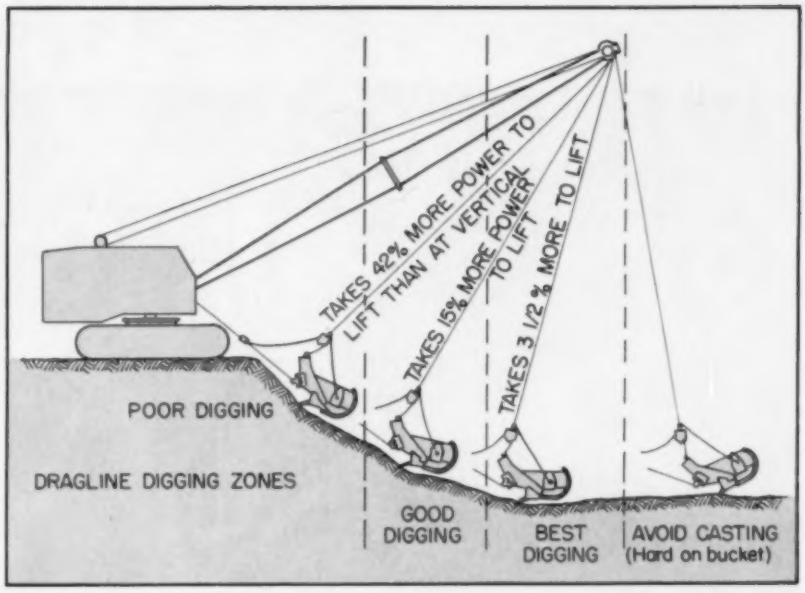
p 74). The number of tractor-scrapers needed for the job depends on how much of the total cover can be moved by the scraper and how much overburden must be moved to uncover the coal needed each day. For example, five tractor-scraper units aided by a rooter have removed 30 to 35 ft of cover at an operation working to a 75-ft highwall and producing 1,700 tpd of strip coal. Shovels remove the lower portion of the overburden. A very worthwhile advantage of the scraper method of handling spoil is that little extra work is necessary where backfilling and leveling are required.

Shovels and Draglines—Shovels are available in a wide range of designs and capacities to meet all stripping conditions. For example, a 3-cu yd shovel with a 28-ft boom and 20-ft dipper handle can cut to a 32-ft height. A 45-yd shovel with a 120-ft boom and 79-ft dipper handle can cut to a height of 107 ft. In between these two extremes are a series of units to meet all the conditions where shovels are applicable.

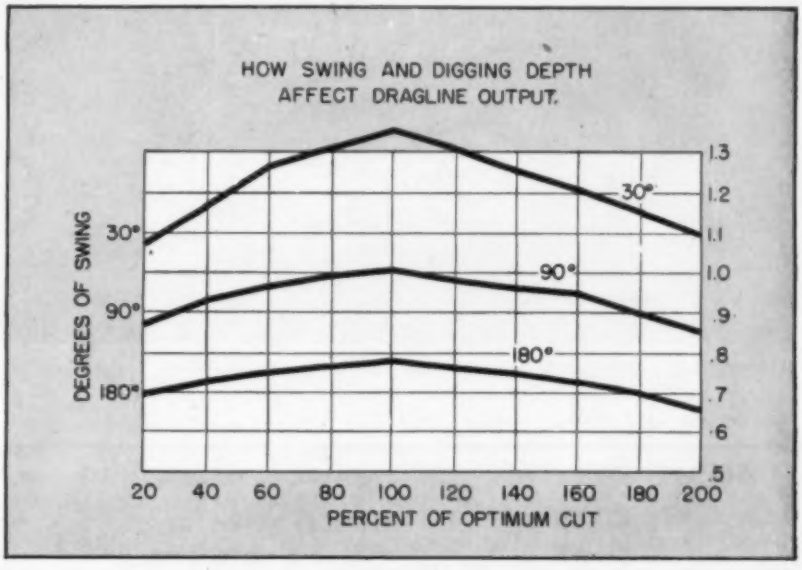
Draglines also are available in a wide range of sizes to meet varying conditions. A 2¾-yd dragline with a 110-ft boom can dig to a depth of 58 ft and spoil to height of 49 ft above the bottom of the bench on which it is working. A 35-yd unit with a 220-ft boom can dig to a depth of 94 ft and pile spoil 98 ft high above the tub. In between these sizes are a host of machines that can handle nearly any assignment.

Big shovels in the 33- to 50-yd range usually work to a maximum of 70 or 80 ft of cover. Removal of overburden between 9 and 50 ft thick by a 45-yd shovel costs about 45% of what it would cost to do the same job with an 8-yd shovel; in overburden between 9 to 90 ft, about 77% of the cost with an 8-yd shovel; and in overburden between 50 and 80 ft, about 25% more than an 8-yd shovel working in a bank 50 ft high. Big shovels also recover coal that would be left by smaller shovels or would have to be auger or deep mined. However, it must be remembered that the area to be stripped must contain enough coal to warrant the capital expenditure for a big shovel.

Flat coal seams and steep slopes cause overburden thickness to increase rapidly as successive cuts advance into the hillside. To meet these difficult conditions, the large walking dragline is most useful because of its long dumping range. The stripping life is increased in proportion to the dumping range of the dragline, and



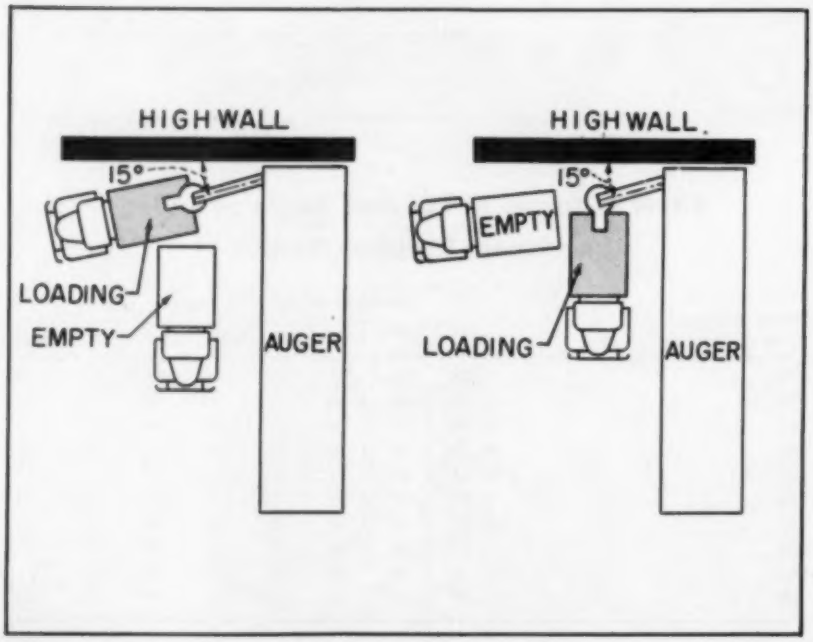
HOW dragline operation affects power consumption and digging efficiency.



Effect of Depth of Cut and Angle of Swing on Power Dragline Output

Depth of cut in % of optimum	Angle of swing in degrees							
	30°	45°	60°	75°	90°	120°	150°	180°
20	1.06	.99	.94	.90	.87	.81	.75	.70
40	1.17	1.08	1.02	.97	.93	.85	.78	.72
60	1.24	1.13	1.06	1.01	.97	.88	.80	.74
80	1.29	1.17	1.09	1.04	.99	.90	.82	.76
100	1.32	1.19	1.11	1.05	1.00	.91	.83	.77
120	1.29	1.17	1.09	1.03	.985	.90	.82	.76
140	1.25	1.14	1.06	1.00	.96	.88	.81	.75
160	1.20	1.10	1.02	.97	.93	.85	.79	.73
180	1.15	1.05	.98	.94	.90	.82	.76	.71
200	1.10	1.00	.94	.90	.87	.79	.73	.69

HIGHWALL AUGERING produces low-cost coal that balances the higher cost of stripping thicker cover and extends the life of the operation. Big units in thick coal produce up to 800 tons per shift.



ALTERNATE SPOTTING of trucks speeds changeover from loaded to empty trucks as auger is stopped for a few seconds, thus increasing coal output.

maneuverability of the unit is advantageous in working sharp angles and inside curves. The disadvantage is that it must have a suitable base and this is sometimes difficult to provide in rocky overburden. This factor must be considered in choosing between a dragline and shovel.

OPERATING STRIPPING UNITS

To get the maximum return from the investment, the stripping machine must be kept working as much as possible, and with no lost motion. To assure the best from shovels or draglines, some companies have installed swing recorders to indicate work time and the number of swings per shift. Load indicators also are gaining in favor to show the operator when the dipper is fully loaded and ready to be hoisted (*Coal Age*, October, 1953, p 80). The operator can be trained to hoist and swing as soon as a full load is indicated on a meter in his cab rather than relying on personal judgment. An indirect benefit from load indicators is less overload-

ing and therefore fewer breakdowns.

Another important factor in good machine operation is reducing cycle time to a minimum. The time consumed in loading, swinging, dumping and returning for a new load must be kept to a minimum. Proper planning of spoil areas goes a long way toward keeping the swing arc as short as possible as the machine rotates between pit and spoil area.

The key to fast loading is a well-prepared bank and the finer the material the faster it can be loaded. But it must be remembered that there is an economic limit to spending money for explosives to break the rock into fine pieces. Each operation must be examined carefully before a decision is made as to how much fragmentation is economically feasible.

Upping Dragline Efficiency—Machine output can be maintained at a high level if the operator handles it in a manner to get the best digging efficiency with minimum power consumption. It is sound practice to analyze the work of the dragline to determine if the operator is getting the most out of the machine.

Proper working of the digging face offers the best opportunity for achieving maximum production from a dragline with a minimum of power consumption and wear and tear on the machine. Slicing material off in layers will give more output than working in trenches. However, a "key" or trench cut along the highwall line frequently will ease the rest of the work. The dragline bucket should be loaded as quickly and hoisted as nearly vertically as possible to keep power consumption at a minimum. Poor operation, such as digging on a slope near the machine and lifting the loaded bucket approximately 45 deg with the vertical may consume up to 42% more power.

Quick loading and immediate hoisting will move the most yardage. By keeping the digging area under the boom, dividends will be reaped in greater output. The bucket should be filled while traveling two or three bucket lengths and then hoisted immediately. Every effort should be made to get a full bucket in the short travel but if it is not completely filled, it is best to lift and swing the load. By hoisting the bucket as soon as it is loaded, dirt pileup in front of the machine will be avoided and the danger of drag rope wear will be eliminated.

Side pulling with the boom overheats and wears swing clutches, puts unnecessary wear on the flanges of the boom-point sheave and may result in a twisted boom. This should be avoided to keep maintenance down.

THIN-COAL RECOVERY is achieved with smaller augers designed for seams as thin as 16 in. Output ranges from 100 to 300 tons per shift, depending on coal thickness.

Bucket Maintenance—Proper handling on the job, coupled with good maintenance procedures, will keep bucket maintenance to a minimum. Among the bad operating practices to be avoided are striking the bucket against a solid object to loosen sticking material; dropping the bucket, especially with the teeth down; slapping the bucket against the boom while hoisting; and pulling the drag-bail socket into the fairlead.

Bucket teeth take a beating and must be kept sharp for good digging. Spare sets of teeth should be kept on hand for frequent changing to permit worn units to be built up with hardsurfacing materials. Under no conditions should teeth be permitted to become badly worn.

Small cracks develop in the bucket from time to time as a result of accidental abuse. These should be repaired as quickly as possible to prevent big repair bills later. Many companies find it profitable to buy a minimum of two buckets for each dragline so that bucket maintenance can be done on the regular work shift without reducing dragline output. When repairs are needed the bucket is changed on the off-shift, or with a minimum of delay if the dragline works around the clock. Two buckets kept in good condition and used alternately will last longer than buckets bought one at a time and used continually until worn out.

Shovel Operation—As with dragline loading, the bank should be removed in slices in shovel work also. The thickness of the slice should be such that the dipper will be filled as it reaches the top of the bank. It is usually good practice to dig the top half of a high bank first. This keeps sloughing into the pit to a minimum and avoids lowering of the dipper to the bottom each cycle. Consequently, cycle time is speeded up and output is increased.

Short moves should be made to maintain an efficient digging position. Digging beyond the boom point should be kept to a minimum. When working with too much reach, too much time is lost crowding and retracting. Sweeping the dipper back and forth to level off spoil causes side strains and wear on the boom, dipper stick and dipper.

PIT CLEANING

Pit cleanup should not be done at the expense of reducing the operating efficiency of the stripping unit. It must be remembered that the goal in stripping is to keep the stripping unit working at full capacity. A great deal of valuable time can be lost by attempting to clean up widely scattered boulders that can be cleared from the coal by an auxiliary unit,

COAL CLEANING begins in the pit where power sweepers like this remove fine dirt from the top of the coal as the last step before loading.

COMBINATION drill and sweeper performs double service and speeds coal preparation to increase over-all efficiency and conserve manpower.

SCOOP SHOVEL is an effective unit for skimming off thin layers of coal that could not be loaded easily with a conventional shovel.

such as a bulldozer. The money spent on an auxiliary dozer and operator in most cases will be more than repaid by an increase in output of the stripping unit and therefore in coal output.

However, it usually is more economical to have the stripping unit scale down loose material on the highwall as stripping is done than to trim the wall later with the coal-loading unit. In some cases, particularly where the cover is thick, it may be impossible for the coal shovel to reach loose material and therefore some coal will have to be bypassed until the next cut is uncovered. This makes a ragged pit and may result in some coal being lost under the spoil bank.

STRIPPING THICK COVER

Where extra thick cover is constantly present, the big dragline is the most popular machine. However, there is no fixed rule regarding equipment application and many combinations of machines are doing yeoman duty. For example, a shovel may be teamed with a dragline in a tandem operation to remove thick cover that could not be handled readily by either alone. In this type of setup, the drag works ahead, taking the upper section of the overburden and leaving the remainder for the shovel. The percentage of material to be handled by each unit depends on the capacity of each and the stripping conditions.

Various other combinations are being used in tandem operations. Where there is a fairly thick layer of soft material at the surface, tractor-scrapers and bulldozers can work on the highwall and cut down a sizable portion of the overburden. Auxiliary equipment also can be used effectively on the spoil pile to permit stripping units to work to higher banks. The choice of equipment depends upon the job and the quantity of material to be rehandled. Where auxiliary units work on the spoil bank, they frequently do a great deal of leveling so that final reclamation or backfilling is not too costly.

If only one machine is desired for stripping under consistently thick cover, the dragline usually gets the nod. Improved electrical controls and bigger motors have made it possible for the drags to work to higher banks and move more cover per hour. The result is more material moved at no greater cost than when working to lower banks. Where shovels would be working at extreme range or working limit, rehandling materials, or working in two lifts the dragline definitely offers advantages.

Whenever possible, thick cover should be removed by casting. How-

ever, there are limiting factors, such as, spoil area available and range of the stripping unit. If the coal seam lies flat, is of average thickness and brings only an average sales price, it usually is not profitable to haul spoil. But if the coal is steeply pitching or is extra thick and the sales price is high enough, spoil haulage is feasible as a means of increasing the stripping range. Spoil haulage is most common in the anthracite area and is being carried on to a lesser degree in the bituminous.

Rugged high-powered end-dump trucks lead in spoil haulage, with tractor-scrapers and rock wagons moving a respectable portion of the material. In many cases, spoil is hauled to worked out sections of the pit, while in others such as hillside stripping, it is hauled to ravines or below the outcrop. The wheel excavator with its stacker belt also may be classed as a spoil hauler as well as a stripper since it carries spoil beyond the limit of the ordinary stripping limit.

When the overburden is too deep for a single stripping unit or when material is unstable in the highwall or in the spoil pile, the tower rig is worthy of consideration. The tower excavator consists of a head tower, tail tower and a scraper-type crescent bucket. Yardage output of this type of stripper cannot be compared with the high-speed shovel or dragline but the machine does serve the special needs of handling unstable material.

A great deal of preparatory work is needed before the machine can be put in operation. A 90-ft-wide road must be built on the spoil bank for the entire length of the pit and a minimum of six cuts from the operating cut. The head tower then is set up on the spoil area and the tail tower on the highwall.

Operating procedure is to take a construction cut on a 15-deg slope upward toward the head tower. After this cut, the tower returns over the same road, taking the highwall as it goes and depositing it as a blanket on the sloped spoil.

The wheel excavator has been developed for use in the United States to cut the cost of moving material in 50- to 85-ft highwalls. The three objectives in using the machine are: (1) to permit handling overburden up to 85 ft thick, placing the spoil far enough away to avoid slides; (2) to cut the cost per cubic yard below that possible with conventional machines of equal size and capacity; and (3) to leave any overburden not moved by the machine so low in height that capacity of the accompanying shovel or dragline will be increased.

Operating experience with American wheel excavators show that they can move 1,700 cu yd of overburden per hour and spoil it a maximum distance of 388 ft from the digging point (*Coal Age*, March, 1955, p 58). Power costs per yard are the same as a large shovel and are considerably less than draglines.

TWO-SEAM STRIPPING

In some instances, both in anthracite and bituminous, two seams fairly close together can be mined profitably where one alone would not be a profitable venture. Or, recovery of a thinner second seam, since overburden removal is necessary to get at the main seam anyhow, provides a low-cost additional source of tonnage. The method of mining and equipment used for multiple-seam stripping depends upon the dip and thickness of the beds; the lay of the land, whether gently rolling, flat or hilly; and the type of rock above and between the seams.

In anthracite mining, multiple-seam stripping usually is on the pitch. Overburden may be moved by any of the standard types of stripping equipment, including draglines, shovels and draglines, or shovels alone. Spoil haulage is common practice.

Where there are flat or nearly flat seams, overburden can be moved by a specially designed shovel (*Coal Age*, August, 1954, p 64); two draglines plus an auxiliary shovel (*Coal Age*, July, 1955, p 56); or a shovel and dragline (*Coal Age*, January, 1953, p 84). The choice of equipment in each case was made to get the best results under the conditions.

The specially designed shovel strips two seams simultaneously from one position in gently rolling country. Both seams are thin and are separated by 16½ ft of rock. Working on the lower seam, the shovel uncovers a 50-ft strip on each level while working to banks up to 60 ft above the upper seam.

The two draglines and auxiliary shovel are used in a flexible setup in gently rolling country to mine two seams separated by 3 to 10 ft of limestone. Where banks range between 50 to 70 ft in thickness, the two draglines work in tandem, and where cover is thinner they work separately. The limestone interval between the two seams is drilled with percussion units and the broken material is cast to the spoil area by the coal shovel on the off shift.

The shovel and dragline were teamed to mine two seams separated by about 40 ft of rock in hilly country. Operating procedure is to remove the lower seam back to the outcrop of the top seam, using the shovel to make a working bench for the dragline which completes the cut. Next the shovel removes part of the cover and makes a bench on the upper seam for the dragline, which strips to a 40-ft bank. After this coal is removed, augering is done to complete mining in the upper seam. The next step is to recover the lower seam, leaving a 90-ft highwall. Augering to a depth of 175 ft in the lower seam is the final stage in mining.

AUGERING

Since the highwall auger was introduced to the industry 6 yr ago, it has grown to the point where it is producing more than 3,000,000 tons a year. When teamed with stripping equipment, such coal-recovery drills have permitted stripping to be done to higher banks. The combined cost of auger coal and strip coal from the higher bank can be made to equal or better the cost when stripping alone is done under thinner cover.

Coal produced by augering usually is dry, clean and has a good proportion of lump sizes. However the proportion of lump usually decreases as the augering depth increases. Where the seam is overlaid by a layer of high-ash coal, selective mining can be practiced and clean coal produced without preparation.

If augering is to be done as part of the stripping operation, it is wise to make preparation as stripping progresses. Care should be taken in blasting so that the highwall will be left unshattered and stable. A highwall slide can endanger the lives of men or result in serious damage to the auger in addition to causing a loss in production. A clean well-drained pit of suitable width for auger operation should be left as stripping progresses. It is much more economical to anticipate the use of the auger and make the necessary preparations as part of stripping than to do it later. It also is desirable to auger as soon as possible after stripping is completed and the highwall is in the best condition. If there is coal remaining beyond the augering limit, solid blocks of coal should be left to permit access for future deep mining. The size of block to be left depends upon the thickness and type of cover, and the thickness and the strength of the coal.

Augering usually is done by drilling single holes to the desired depth with a unit that takes nearly the full seam height. However, for seams more than 5½ to 6 ft thick, it is best to use a smaller auger and double drill, preferably overlapping the bottom hole into

TRACTOR-TRAILERS powered by engines up to 400 hp and with capacities up to 80 tons of coal are favorites for hauling at today's high-capacity strip mines. Payload and speed have increased while trailer weight has decreased.

the top. Staggering top and bottom holes is another method. The depth to which augering is carried out depends to a great extent on the coal thickness, whether the seams roll or are flat, and whether they are strong enough to stand after penetration and not foul the auger. Distance between holes also depends on the strength of the coal and the overlying rock.

Early augers were quite large and required pits up to 90 ft wide. Success of these models led to the development of small ones for use in thinner coal and narrower pits. Today's augers are available in diameters ranging from 16 to 52 in, and are capable of producing as much as 800 tons of coal per shift. To permit greater flexibility in operation, augers are available with conveyors that permit coal to be discharged on either side of the unit. A four-man crew usually handles all the work involved in the augering and is supplemented by a group of truck drivers.

Equipment requirements for augering depend upon the application. For example, if the auger works in conjunction with stripping a bulldozer and trucks will be all that will be needed. Service and maintenance trucks used for the stripping equipment can take care of the auger. If augering is done independently of stripping, either in abandoned strip pits or in areas where no stripping was done, a small shovel and service facilities probably will be needed. The shovel will be needed to provide a working bench along the outcrop or help the bulldozer clean old pits.

SYSTEMATIC SCRAPING of haulage road keeps small holes filled and prevents road from deteriorating. Truck maintenance is lower where roads are good.

Coal Loading

The question of whether coal should be broken with explosives before loading can best be answered by a careful study of the physical properties of the coal, the size of the coal shovel, and the presence or absence of impurities in the seam. Where the coal is of average thickness and hardness, explosives used for breaking overburden usually will loosen the coal sufficiently so it can be loaded easily without blasting. Carefully placed holes in the overburden usually will permit explosives to fracture the coal to whatever degree is necessary.

At other operations, it is necessary to drill and shoot the coal in a separate operation. Self-propelled combination machines made up of drills, compressors and brooms are gaining in favor for this work. Either one or two drill arms are mounted on these units to put down holes in a minimum of time. The power broom is used to sweep the top of the coal before holes are drilled in the coal and is disengaged from the power unit when the machine is used as a drill.

Still another tool for preparing thin seams for loading is the pinning machine. This unit travels over the coal on crawlers, dropping a weighted, pointed steel pin or pins that pierce

LATEST ENTRY in the transportation field is the overland belt receiving coal from a field station and carrying it to a stockpile at the preparation plant. Belt extensions are made every 2,000 ft.

REGULAR SPRINKLING of roads in dry weather keeps dust down and helps maintain a smooth running surface so trucks can operate at top speed.

the coal and fracture it enough to permit easy loading. The advantage of this machine is that the coal can be broken as quickly as it could be drilled, the cost of explosives is eliminated and a minimum of fines is produced.

COAL CLEANING

Preliminary cleaning before loading, where desirable, can be done by tractor-scrapers, bulldozers, graders, rubber-mounted scoop loaders or power sweepers. If there are any clay veins in the coal or the top of the coal is very irregular, it may be necessary to remove part of the dirt by hand. Hand cleaning, however, is expensive and should be avoided where possible.

LOADING METHODS

There are available for the loading job a variety of units with capacities and design features to fit any pit condition. First consideration in choosing a coal-loading machine is to get the right capacity. This means matching loading capacity to the stripping capacity. In some cases it might be desirable to have some excess capacity in the coal shovel in case of hard digging, or transportation or tipple delays that jam up empty trucks at the loading point. By loading trucks rapidly, with an oversize shovel, the haulage cycle can be put back to normal with a minimum of time required.

If the coal seam is thin, it is well to consider the horizontal-thrust shovel or the skimmer unit, either of which moves the dipper parallel to the bottom while loading. These units have the advantage of scooping up a wide channel of coal without disturbing the bottom. In other instances, a conventional shovel equipped with a specially designed dipper is a satisfactory unit for loading coal.

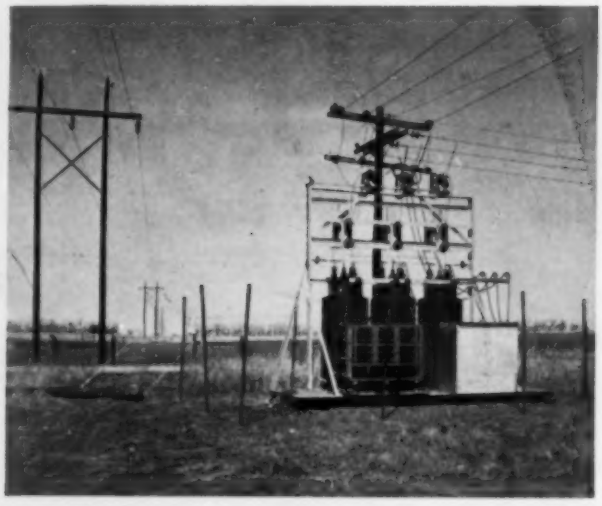
If the coal seam is split into two or more parts by several feet of rock, the specially designed dipper on a conventional shovel may work out better. The top layer of coal can be scooped off and then the same shovel can be used to remove the rock covering the lower portion of the seam. If the coal loader cannot be spared for the rock job, the regular stripping unit can be used on the off shift to remove the thin layer of rock.

When the coal is more than 2 or 3 ft thick, but is extremely hard, a divided dipper can be used effectively to limit the size of lump that is delivered to the truck and therefore to the preparation plant.

Where two-shift operation of the preparation plant is not desirable and the coal is thin, top efficiency from the loading and hauling units can be achieved by heaping the coal to one side of the pit on the off shift so that loading time will be as low as possible on the regular shift. The loading shovel thus can load a truck faster and coal will be carried to the tipple at a faster rate.

Increasing Coal Recovery—The im-

MODERN POWER FACILITIES include skid-mounted switchhouses readily moved as stripping progresses.



WELL-DESIGNED power systems with safety and overload protection are the life blood of modern operations.

Adequate Power for Operating Units a Key Factor in

portance of recovering all the coal that is uncovered cannot be overemphasized, particularly where the seam is thin. If by careless operatioa of the coal-loading shovel 3 in of coal is left on the bottom over an area of one acre, the loss will be about 450 tons. If 10 acres of coal are stripped in a month, the resulting total loss will be 4,500 tons. At a sales price of $4 per ton, this amounts to $18,000 per month.

If working completely to the bottom results in much over-shooting or in too much loss of time, and there is considerable coal involved, a bulldozer may be assigned to accompany the loading shovel. It can rip up the bottom coal—with the aid of scarifying arrangements if necessary—and keep it pushed up to the loader with a minimum of digging into the bottom and at a cost still representing a considerable saving over leaving the coal or delaying the loading. If a washing plant with sufficient capacity is available, some bottom material can be tolerated with either shovel or bulldozer cleanup. If a washer is not available, more care is required, but it still is possible under many conditions to increase recovery without undue contamination.

Another place where good loading procedure pays off is along the outer edge of the coal where it is in contact with the spoil. If a 6-in strip of coal is left along 1 mi of it in a seam of coal 60 in thick, the loss will be about 528 tons of coal. At $4 per ton, this will be $2,112. To provide a solid vertical edge and prevent losses such as this, one company developed a marking machine that shears through the coal, marking the loading limit for the shovel and leaving a smooth vertical wall on the bench. Estimated savings were about 200 to 400 tons per acre (*Coal Age*, November, 1949, p 80).

Transportation

Good haulage today depends upon modern equipment installed and used in a workmanlike manner. The rugged end-dump truck and semi-trailer are the favorites for coal haulage, with the overland belt from pit to preparation plant an added starter in the transportation field. To pick the most suitable equipment or combination of units for the best haulage results, a careful analysis must be made of the job to be done.

The largest available unit does not always mean a lower cost per ton because final truck selection is based on many factors including production, pit width, type of roads, grades, distances and size of loading shovels. Wherever possible, the size of the haulage unit should be matched to the size of the loading shovel. For example, a 5- to 7-yd shovel works well with a 40-ton truck and a 3- to 4-yd shovel teams well with a 25-ton hauler. A good rule of thumb is to use trucks with four to five times the dipper capacity of the shovel.

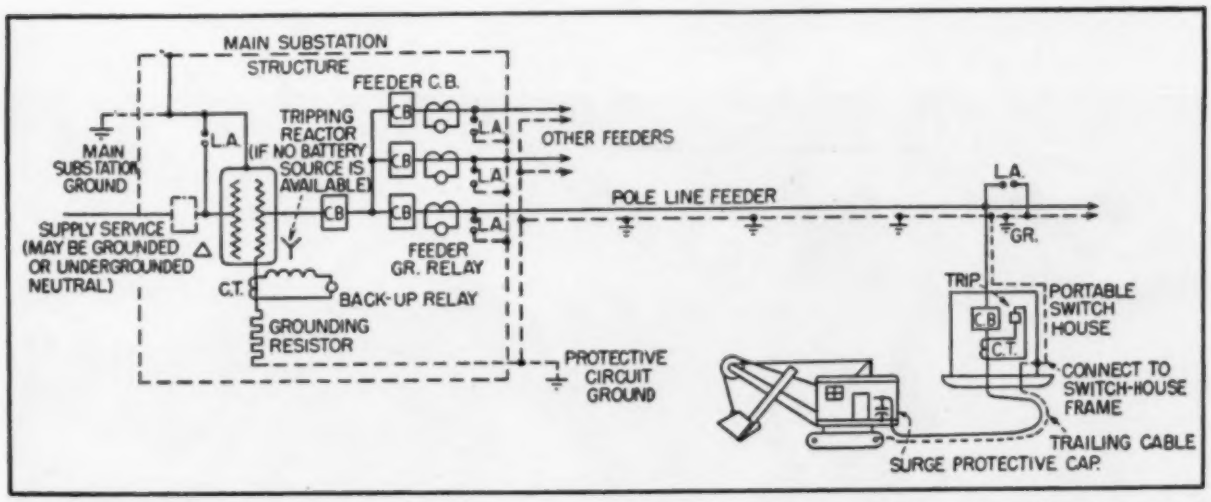
Overall height of the truck should be such that it makes a good target for the loading shovel. Length should be a minimum and width a maximum so that the shovel loading cycle can be kept to a low value. Ability of a truck to turn around in cramped quarters in as short a time as possible and get under the shovel without delay should be considered to avoid traffic congestion.

Coal-hauler size runs up to 50 tons in anthracite, and up to 70 tons or better with tractor-trailer units in bituminous. Power is supplied by engines up to 400 hp. In the past 5 yr trailer weight has decreased, and payload and speed have increased by 25 to 30%.

Torque converters make for smooth truck operation, less lugging and lower maintenance. They also have made it possible for loaded trucks to climb steep grades, thus shortening haulage routes. In some cases, a 48-ton truck with torque converter can haul coal at up to 30% less per ton-mile than a 37-ton truck with a standard transmission on the same route.

Air starters have been used effectively on large coal haulers to eliminate all batteries except the 6-v units for headlights. Starters are operated by compressed air supplied at 100 psi from a storage tank on the tractor. Trucks can stand idle for 4 or 5 days and there still is enough air in the tanks to start them.

Where the haul is over 3 or 4 mi, the topography is favorable and sufficient coal reserves are available, the use of a field station and rail haulage to the preparation plant is worthy of consideration, particularly since the advent of the small diesel locomotive. With this type of setup one man can



POWER-DISTRIBUTION SYSTEM with grounded neutral includes the features needed for protection of men and machines against short circuits and overloads. The circuit is deenergized immediately if a ground fault occurs.

Modern Stripping Operation

load a trips of cars, haul it to the preparation plant, dump it and return to the field station in a minimum of time. A minimum of trucks are needed to shuttle back and forth between the pit and the field station. Consequently, truck maintenance costs also are lower and fewer men are needed for operating and servicing trucks. A further advantage is that road maintenance will be lower.

An added starter in the transportation field is the overland belt system that carries coal from portable bins near the pit to the cleaning plant (*Coal Age*, August, 1954, p 64). Where the land is gently rolling and stripping can be carried out in a wide area, the overland belt offers the following advantages:

1. Eliminates the cost of building and maintaining long high-speed haulage roads.

2. Permits movement of larger tonnages with fewer and/or smaller trucks.

3. Permits recovery of belt after the property is worked out. Roads cannot be recovered.

4. Reduces the manpower required for maintenance of trucks.

5. Requires a smaller supply inventory and less garage space.

ROAD BUILDING

Where haulage is completely on roads, it is of vital importance that a good running surface be provided. Main roads should be built with wide road beds and have good alignment to permit trucks to run at top speed. All curves beyond the gentlest should be superelevated. Roads should be planned well in advance and when fills are needed to get the proper grade, they should be built up well ahead of the time they are needed. Fills should be compacted as they are made and topped off with one or more feet of rock that will serve as a road base. After this material is compacted, a top layer of crushed rock should be added and compacted. This top layer usually is applied in several layers and compacted between each. Material used for the top layer includes Nos. 3, 4 and 6 crushed limestone, 2-in slag or red dog. One or more road graders, depending on the length of road to be maintained, are used at most operations to keep the running surface smooth. Roads should be sprinkled regularly during the dry, dusty season.

Grades should be avoided as much as possible to keep power requirements down. For example, it takes twice as much force to move a 20-ton load up a 5% grade as on the level. Where grades must be negotiated, stepped-type roads can be used to advantage. This type of road involves alternate stretches of level road and short, comparatively steep rises. Therefore less clutching is required in trucks equipped with standard transmissions and there is less lugging on the up grade and overspeeding on the down grade. Constant shifting and lugging results in reduced life for engine, transmission and clutch.

Power

Most power for strip mining is purchased from privately owned public utilities, at voltages ranging from 6,600 to 66,000 volts. Most commonly, the voltage is 33,000 though higher voltages are becoming more frequent. With one-step transformation, primary mine distribution usually is 2,300 or 4,160, with 6,600 and 7,300 volts coming into the picture as a result of heavier demands imposed not only by the increase in machine use but by higher horsepower per machine. In two-step transformation, the "super-primary" voltage usually is 13,000. Permanent transformer stations may employ either single- or three-phase transformers, with a trend toward the latter. A number of strip operations also employ semi-portable stations completely or to supplement permanent stations. Commonly called unit substations, they are based on three-phase transformers. Typical ratings are 1,500, 2,000 and 2,500 kva, with the top usually 5,000. Normally these stations include lightning arresters, circuit breakers, ground-protective equipment and other central and protective facilities.

Primary distribution systems generally fall into two general classes:

1. Pole-mounted high lines.
2. Cable systems.

A third version is a combination of pole line or lines and cable line or lines. Pole-line practice is largely standardized, with a main line a maximum of 1 mi in advance of the pit and

DIVERTING STREAMS to recover coal is a job that requires planning and skillful use of various types of equipment.

PLANNED DRAINAGE to handle water at as low cost as possible includes strategically located pumps and adequate pipe lines.

parallel to it. From this main line, pole-line laterals at intervals of 1,200 to 1,500 ft are run to the pit, terminating in switchhouses which supply auxiliary transformers for low-voltage equipment, and also supply the cables on the larger high-voltage equipment. As the pit moves across country, the laterals are shortened at intervals until the pit approaches the main line, which then is moved to restart the cycle. Cables on the equipment usually are 1,000 ft long. Thus, with a lateral spacing of 1,200 to 1,500 ft, equipment can operate freely between laterals with enough cable to spare to permit terminating laterals some distance back when shortening is necessary.

Ground-Cable Systems—A fair number of strip mines use the "ground-cable" system instead of pole lines, or a combination of ground cables and pole lines. Otherwise, the basic plan is the same. A complete system consists of the main cable and the laterals, the cable being fabricated in sections of 1,000 to 1,500 ft as a rule with connectors for termination in switchhouses or for joining the main-cable lengths by junction boxes. Several types of cable may be employed but the most common is Type SHD. Construction includes copper shielding braid over each insulated conductor to equalize surface stresses and eliminate static discharge—the cause of corona cutting. The shielding must be at ground potential at all times, and therefore must be properly grounded, which also eliminates the hazard of shock in handling the cable. Grounding conductors are placed in interstices. It is the safest and most widely used for high-voltage (up to 15,000) portable power applications.

Within limits, distance of transmission of 4,160 volts becomes critical, as a rule, only with the heavy loads encountered in the use of large shovels and draglines rated from 20 to 25 cu yd and up where connected horsepower per unit runs from approximately 2,000 to 5,000. Under such circumstances, the transmission distance for 4,160 volts normally should not exceed 5,000 to 6,000 ft. Above that, at high-voltage—33,000 for example—a pole line is cheaper to construct and also improves regulation and reduces power loss.

From a previous top of 46 to 50 cu yd, dipper capacity reached a new high of 60 cu yd in 1955. At the same time, a new high in connected horsepower, main AC motors, was established, resulting in a decision to break another barrier—operating voltage. Compared to the previous high of 4,160, the new shovel was designed to operate on 7,200 volts. Peak power demand will be 6,840 kw.

Protection—Basic protection includes station-type lightning arresters with,

PREVENTING INFLOW can be achieved by spanning pits with pipe or flumes.

for example, 50-amp fuses on the primary side. On the secondary side, aside from standard breaker and other facilities for overload, etc., standard practice in distribution is Y-connected transformers with ground resistor and current transformer in the ground wire to trip the cable-feed breaker. A newer form of ground trip employs a "doughnut"-type transformer around the three phase wires. Any unbalance resulting from a fault is detected by a special current transformer, which trips the breaker through the usual facilities. Compared to a normal voltage of 2,000 (4,160-v service) between machine frame and ground without facilities of this type, grounding as described normally limits the voltage to 100 during the interval before the breaker trips to take the machine off the line.

Power Factor—To prevent power penalties resulting from power factor below that specified in the power contract, synchronous motors, 0.8 leading, are installed on the m-g sets on large excavating units. Without correction, power factor would be usually average between 68 to 85%, but with the proper correction will be up to 90 to 95%, which will be above the penalty area.

Cable Testing and Fault-Finding—Insulation failures and shorts in high-voltage distribution or service cables in strip pits can cause major delays unless special facilities are provided for locating them. Without such special equipment, about the only method is to apply high voltage and current and blow the cable up at the point of fault.

Equipment for testing and fault location may be made or purchased. A testing outfit that may be made up from purchased components employs, among other items, a half-wave rectifier tube and filament and plate transformers to produce DC at up to 30,000 v and 40 milliamp, or sufficient to test up to 7,500 v. In operation (*Coal Age*, May, 1953, p 108) voltage is applied slowly to one conductor, with other conductors, shield or shields and ground wire or wires grounded. When the cable is fully charged, the current flow is the true leakage current, registered on a milliammeter. The voltage is held for a period and leakage current is determined at intervals to develop a polarization curve. The shape of the curve indicates the electrical condition of the cable and exposes potential insulation weaknesses.

For locating faults, the test equipment is modified by the addition of a spark gap and condenser. Location is achieved by picking up the discharges sent forth by the condenser and spark gap, which are audible at the trouble spot if there is water soaking or there is not a dead short. Where this is the situation, the observer has only to walk the cable. If the fault resistance is very low, dead ground or under water, a pickup coil and earphones are employed and the fault point is marked by a change in the signal. Commercially developed units may be purchased to achieve the same results.

Drainage

The aim in drainage is to handle water at as low cost as possible. Good drainage procedures can pay off in lower material cost and less labor. Also men and equipment will perform better if the working area is kept free of water.

To keep drainage costs to a minimum, water should be kept from entering the pit and off the haulage roads. Several ways of doing this include: (1) diverting streams to new channels to prevent seepage into the work area; (2) ditching above the highwall to divert surface runoff away from the pit; and (3) building flumes to span the pit.

When water does enter the pit, as a result of rainfall or seepage, gravity should be used as much as possible to remove it. By exercising care in spoiling, leaving windows in the spoil areas or putting in crib culverts or drain pipes at intervals, water can be handled economically. If grades favor it, one end of the pit may be kept open to release all the water. In some cases it will pay to blast a ditch in the pit floor to permit water to flow by gravity to a drainway in the spoil.

Portable pumps, either mounted on skids or wheels, are the leaders where pumping is required. These are used in a variety of sizes and capacities, depending on the job to be done and are powered either by electric or diesel motors. Many of the units are controlled by float switches that stop or start them automatically, thereby cutting labor costs.

The hose is popular for temporary water lines but is frequently supplemented by a variety of new materials, including flexible plastic, special rubber and aluminum pipe. Resistance to corrosion, rot and abrasion have made plastic pipe more popular, while ease of handling makes aluminum desirable. Threadless couplings, in addition to the advantage of fast joining and installation of pipelines, also permit individual joints of pipe to be rotated 180 deg if a small leak occurs in the bottom as a result of abrasion. Thus pipe life can be greatly increased. Check valves should be included in all suction lines to eliminate the need for priming pumps, However this may not be desirable in weather when there is danger of the lines freezing. If corrosion and abrasion are problems, impellers and pump interiors can be coated with rubber-base material to increase their life.

The Preparation Guidebook

BUILDING BUSINESS by making coal more economical, convenient and satisfactory for the user is the goal in preparation. The four major methods of achieving consumer satisfaction are:

1. Proper size for the particular application.

2. Maximum Btu content per dollar spent by the consumer through elimination of impurities and moisture. Good sizing also plays a part here, too, by making possible more complete combustion and thus more liberation of heat at the point where it can be effective.

3. A high degree of uniformity in all characteristics—size, heat content, ash and so on—meaning a product on which the consumer can depend day after day and year after year. Uniformity can be even more important than, for example, maximum impurity removal.

4. Maximum convenience in use. For example, should the coal be treated to eliminate dust in handling? Should the coal, if washed, be dried or treated with chemicals to eliminate unloading and handling difficulties in freezing weather?

Designing for the Market

In setting up a preparation plant or system to attain the preceding goals today—and in the foreseeable future—the first job is to ascertain to the maximum degree possible what the market will require in:

1. Size of product. For example, the trend still is toward the smaller sizes, and is being accelerated by the growing use of coal by the utilities.

2. Ash, sulphur, heat and moisture content.

3. Dustproofing, freezeproofing and other convenience factors.

Next, the coal itself must be studied. It may, in its natural state, provide some of the desirable qualities—or in some exceptional cases, all of them. Where it doesn't provide them, can it be treated so that it does? The latter question usually is the critical one. It may be possible to process a certain coal to meet very rigid requirements for ash, but in the processing it may be necessary to reject an excessive percentage of the raw feed. Therefore, when all the pros and cons are weighed, a greater realization may be secured by a higher ash and a higher recovery with a high degree of uniformity. In the last analysis, in fact, the test is economic, meaning a balancing of realization, plus the promotion value of being able to offer a processed product, against the cost—in equipment, in labor or in loss of raw feed—of achieving certain specifications.

The importance of preliminary study and analysis of market requirements, coal characteristics and possible beneficiation methods can hardly be over-emphasized in building or rebuilding to satisfy the consumer at minimum cost now and in the days to come. Organizations to which coal companies can turn for help include commercial testing laboratories, preparation consultants and engineers, and designers and builders of plants and equipment. Quite frequently, it is well worth running up to several days' output through various types of equipment in pilot or actual operating plants to determine exactly what can be done in mechanical cleaning, for example.

Designing for Low Operating Cost

Actual cost of the preparation operation also is a question meriting the most careful study. Operating labor, including labor for such things as hand picking, is a critical factor. Operation with not over 4 or 5 men is fairly common today.

Maintenance also is critical. Proper design and the use of modern materials is the best way of preventing the spectacle of a maintenance crew as large or larger than the operating crew taking over at the end of a day of plant operation. Then there is the question of changes and plant additions—which are a normal part of the conduct of plant operation. Proper design speeds these changes by providing working space and places to put the new units that changes in the market indicate will be necessary in the future though not required when the plant was first built.

Raw-Coal Storage

PURPOSES:

1. Preventing interruptions in mine operation from shutting down the preparation plant and vice versa.

2. Providing some degree of blending of the raw feed to the plant.

3. Providing a means of evening out the flow of coal to the preparation facilities, thus permitting washing equipment, for example, to do a better job.

CAPACITY

Even where raw-coal storage facilities are underground, the prevailing practice is to provide at least ½ hr of the rated capacity of the mine or plant, with 15 min as about the minimum for anything more than a hopper to hold a car or two. From 15 min to ½ hr also seems to be the rule at most strip-mining operations receiving coal from trucks.

A trend toward even larger storage capacity seems in evidence, however. Examples include the following:

Deep mine, outside bin mounted on structural members under a dump bridge and receiving coal from drop-bottom cars, 2,500 tons of capacity for a plant rating of 700 tph.

Deep mine, 5-compartment silo mounted on hill above plant, 2,200 tons for a plant capacity of 600 tph.

Deep mine, single concrete silo, approximately ½ day.

Where ground storage is provided, capacities up to 2 or 3 days are provided in some instances, as follows:

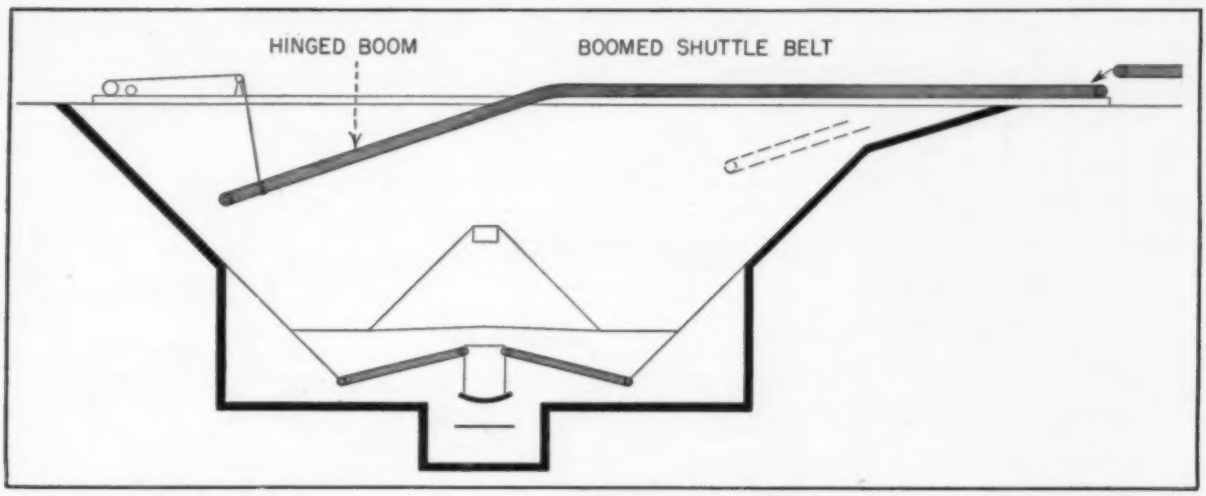
Deep mine, bin over slope belt with feedback belt from preparation plant, 10,000 tons, including ground area around bin.

Deep mine, ground storage with feedback belt over glory hole back to slope belt, approximately 1 day.

Strip mine, ground storage at preparation plant, several hours' capacity, conventional reclamation equipment.

UNDERGROUND STORAGE

Illustrated is a 260-ton hopper feeding a slope belt at a plant rated at 500



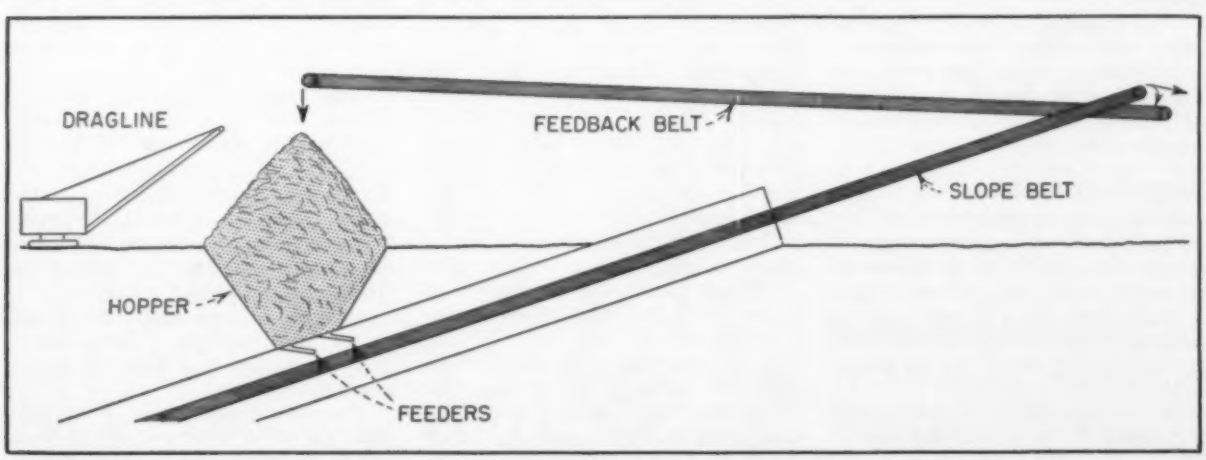
BOOMED SHUTTLE BELT moves back and forth to utilize entire capacity of underground bin placing coal on slope conveyor dual feeders. Coal comes to the underground hopper by main-line belts.

tph. The hopper is 16 ft wide and 66 ft long. Maximum depth is 18½ ft. Designed to receive coal from a belt system, this hopper is fitted with a shuttle-type distributing conveyor with hinged boom end. The boom section permits laying coal into the hopper with minimum degradation. The shuttle principle also makes possible maximum use of bin capacity.

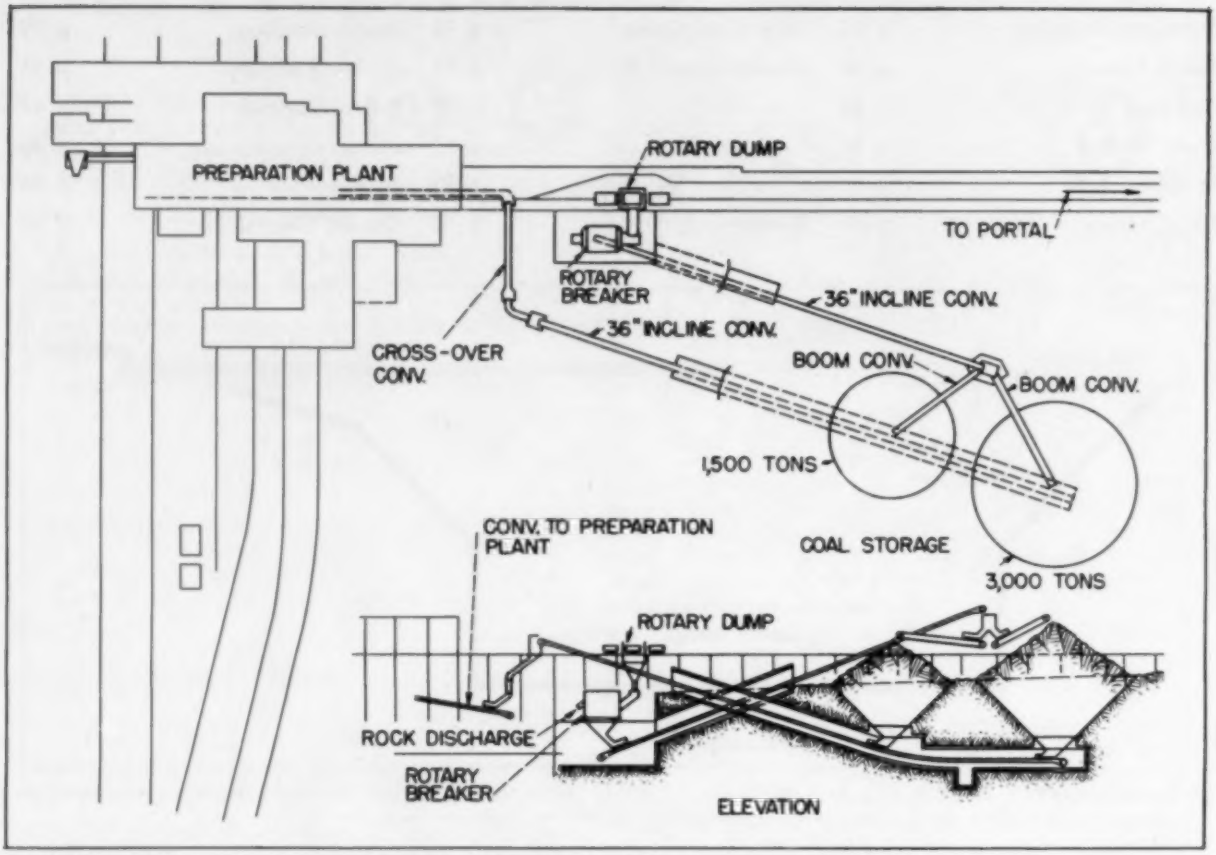
The dumping characteristics of dropbottom cars also permit maximum use of bin capacity and thus can cut down size and depth; for example, 96.7 tons in a bin 40x12 ft by 10 ft deep.

Separate smaller rock bins next to the main bin for direct dumping or so located that a flygate can divert rock into them are employed where it is desired to keep coal and rock separate. Normally, dumping is by mine cars, but even hoppers designed to receive coal from belts can be arranged in this fashion provided rock loading onto the belt is sufficiently segregated from the coal.

Underground bins may be lined—concrete, steel plate, etc.—or, if the rock is of the proper character, left in



SURFACE STORAGE with feedback belt permits accumulating large reserves of raw coal if desired, using a dragline, scraper or other means of reclaiming to glory hole and feeders returning the coal to the slope belt.



GROUND STORAGE here involves rough cleaning, distribution to two funnel-shaped pits via boom conveyors, and reclamation by feeders to subway conveyor. Storage and reclamation is either automatic or remotely controlled.

their natural state except perhaps for concrete or steel around the feeder throat, or at other strategic locations. Lining may be desirable even where the natural rock is good to permit the coal to slide at a lower angle and thus somewhat reduce bin size for a given capacity.

Dual throats and feeders are installed at times where conveyor capacity is high for greater ease in transfer from hopper to conveyor. Also, trouble with one feeder does not halt the entire operation.

SURFACE STORAGE

Although some form of bin or hopper still is the most popular form of surface storage of raw coal, there is, as previously noted, a trend toward open or ground storage. Where space is available for ground storage, the quantity that can be stored can be greatly increased with a minimum of investment. In other words, the cost of bins or hoppers is eliminated, but part of this saving normally is offset by the fact that some type or types of stocking and reclaiming equipment is necessary, even for relatively small tonnages.

An example of a 10,000-ton ground storage installation is shown schematically in the accompanying illustration. As coal is fed back to the slope belt, it eventually becomes necessary to use a reclaiming unit—in this instance, a dragline. A glory hole may be substituted for the hopper shown.

Reclamation by subway conveyor is provided for in the recent plan for surface storage shown in another accompanying illustration. From the rotary dump, the coal goes to a rotary breaker for size reduction and removal of hard, heavy rock. It then goes onto an inclined conveyor feeding a distributor hopper. From this elevated hopper, boom conveyors put the coal into either of two conical storage piles. The flygate switching coal from one boom conveyor to another is remotely controlled, and electrodes are installed on the ends of the boom conveyors to raise them automatically when the coal level reaches them. One of the funnel-shaped storage pits has a capacity of 3,000 tons; the other, 1,500 tons. Feeders under the pits put the coal on the reclaiming conveyor. A more uniform raw feed to the plant, with better final quality, is one of the expected advantages of the installation.

Ground storage may be accomplished by dumping from trucks in a flat pile with bulldozer spreading. Reclamation may be by standard shovel and trucks or by tractor-mounted shovels. Another method of stocking is to use a conveyor with an elevated end, receiving coal from trucks, headhouse or tipple. Piling the coal high in conical shape reduces to some extent the ground area required. Pivoting the conveyor to permit continuous stocking in an arc increases capacity per square foot of ground area. And where trucks are employed, a variation applicable to hilly country is to excavate a bench in the hill, with trucks dumping over the back wall and conventional equipment picking up the coal as desired from the bench.

Storage of large quantites of coal in piles or elsewhere requires checking against the possibility of spontaneous combustion.

The conventional square or rectangular bin—steel, concrete or timber—still is the most-used method of providing raw-coal storage where open or ground storage is not employed. Two old hopper cars, one on top of the other, have been used in some instances. However, the round, or silo-

type, unit is being increasingly installed. The silo may be built by conventional concrete-pouring methods or may be constructed of regular plate or prefabricated steel sections, or of precast concrete staves bound with steel hoops. A silo 24 ft in diameter and 55 ft high will hold up to 600 tons of coal.

Hilly country provides an opportunity to build the rectangular bin directly on the ground where it can receive coal directly from the dump. However, a number of installations in hilly country in recent years consist of square or silo-type storage bins set out from the dump and fed by conveyors. In flat country, elevated bins naturally are a necessity, and are fed by conveyor or elevator, usually the former.

Compartmented or multisilo bins are employed at a number of mines for greater flexibility in storage and also to provide some degree of blending of the raw product. Distribution to a side-by-side or four-cornered multiple unit may be by chutes and flygates. Indicators and remote-controls permit operation of gates and proper distribution without having a man at the bin.

Distribution to long multi-compartment bins may be handled by a distribution belt with tripper. Other methods include a wheel-mounted shuttle belt similar to that employed in loading railroad cars which is moved back and forth to place the coal in the proper compartments. Or a scraper conveyor with fixed openings or movable gates may be used.

In deep bins, degradation may be reduced by installing spiral or ladder-type lowering conveyors.

A growing practice reflecting, among other things, the growth in full-seam mining, is combining rough cleaning and preliminary crushing (if practiced) with surface storage of raw coal to conserve labor, improve plant maintenance and raise plant efficiency, as in one of the storage plans summarized previously in this section.

Raw-Coal Blending

PURPOSES:

1. Assuring maximum uniformity in the characteristics of the coal fed to cleaning units and thus in turn, assuring a better final product by enabling the units to do a better job. Uniformity of characteristics in the final product is especially important in metallurgical coal, and the majority of blending plants to date are at metallurgical mines.

2. Providing storage capacity and evening out the rate of flow to cleaning units, thus helping to promote uniformity and quality in the final product in another way.

Since the goal in blending raw coal is splitting it up into small increments and then recombining it, also in small increments, the normal blending plant consists of a multicompartment bin with a relatively large capacity—usually 1,000 to 2,000 tons or more. The more the compartments, within reasonable limits, the more the opportunity for splitting and recombining. Also, to facilitate putting small portions of coal into each compartment, the usual practice is to employ a belt with a traveling tripper, though other methods of distributing the coal may be employed. To complete the recombining—and blending—coal normally is withdrawn from all compartments at the same time. Variable-speed feeders are common for this purpose, and permit changes in individual feeding rates to compensate for changes in needs or conditions.

Normally, the coal is placed in the blending plant after preliminary cleaning and crushing.

Withdrawal from blending bins may be by fixed-rate feeders for each compartment discharging to the gathering unit. A refinement is adjustable-speed feeders to permit varying feeding rates as desired. Concrete is the usual construction material for blending bins, though other materials may be and are used.

Preliminary Breaking

PURPOSES:

1. To reduce all oversize material in the raw feed to a certain top size, say 6 in, usually done where the market for lump is considered too small to warrant preparing this size.

2. To reduce extra-large lumps without especially attempting to get everything to a certain top size. Convenience and smoothing out the flow of coal through the plant are the major objectives in such breaking. Freeing bone or partings from coal to facilitate picking or cleaning is another objective in some instances.

Preliminary breaking and certain rough cleaning usually go hand in hand, although, for example, if coal is being transferred from a hopper to a crusher preceding a slope belt underground, no attempt is made as a rule to remove rock or impurities before the breaking process. On the surface, however, it is generally accepted that where substantial quantities of rock are encountered it is best to remove at least part of it before sending the product to the crusher. Consequently, particularly where all the coal is to be washed, it is common practice to employ a picking table or—as is increasingly the case—a scalping screen and picking table ahead of the crusher.

Preliminary breaking is almost entirely the province of the roll-type machine although some pick breakers are employed to get closer to the desired objective of reduction with a minimum production of fine sizes. Roll diameter, tooth design, tooth positioning and speed are major factors, along with keeping teeth in good condition at all times. Double-roll crushers are considered to give a higher proportion of coarse material because abrasion against the plate is eliminated. Feeding practice also influences results in this direction. Consequently, usual practice is to scalp out fines and send only large material to the crusher.

In anthracite particularly stage crushing has been the practice for many years because of the nature of the raw product and also the size list produced. In anthracite it sometimes happens that the rock exceeds the coal in the raw feed and therefore picking sometimes is set up to remove coal from the rock rather than vice versa. Whatever the system, however, after scalping out the fines, the coarse coal goes through the first rolls, after which the process of scalping and additional breaking of the large material may be repeated a second and even a third time.

To avoid a multiplicity of units, crushers are offered with a second stage of reduction built into them.

Crushers normally are built to handle iron, particularly if it is not too large. However, the better practice is to keep it out not only of crushers but of the entire plant circuit. If possible, therefore, magnetic removal equipment should be installed ahead of raw-coal crushers; if not possible, at some logical point following crushing, or ahead of the raw-coal screen if preliminary breaking is not the practice. Iron removal is considered a good practice even where washers are employed, since it reduces the possibility of plugging and damage to equipment up to and including the washers.

Rough Cleaning

PURPOSE—Quick removal of coarse rock and other impurities to reduce the burden on subsequent preparation

units and also to permit higher efficiency in the removal process itself.

The major rough-cleaning methods are as follows:

1. Use of a picking table receiving all the mine-run product.

2. Use of a scalping screen followed by a picking table. This is the preferred system, since it removes the fines and thus facilitates picking, which may be either rough with the idea that final impurity removal will take place in mechanical cleaners, or may be final where the coarse coal is to be loaded without any further treatment.

3. Use of a rotary screen-type breaker, which accomplishes both a reduction to a certain top size, depending upon the size of perforation, and rejects the hard rock—or at least that portion of it larger than the perforations. Normally, where rotary breakers are employed final cleaning is done in mechanical equipment.

4. Use of roughing cleaners to throw out the major part of the heavy material and prepare the feed for the final units. Fines may be by-passed around the roughing unit, while large lump usually is processed by hand picking. Preliminary breaking may also precede roughing with a mechanical cleaner. A further refinement is hand picking to remove coarse, heavy material, followed by breaking and roughing.

Rough cleaning by hand frequently precedes breaking, as noted in the previous section, and has the advantage, among others, of reducing the load on the breaking unit and reducing the output of fine sizes in the breaking operation by getting the hard, heavy rock out of the way.

Separate headhouses or roughing plants are being increasingly employed for preliminary breaking, rough cleaning, mine-rock disposal and raw-coal screening. This is a natural development at hillside mines, but the same practice can be followed at slope and shaft operations. With separate plants, it is easier to put the necessary heavy equipment closer to ground level, reducing structure cost and maintenance. Also, a prime source of dust, noise and vibration is removed from the main plant.

Raw-Coal Sizing

PURPOSE—Separation of the feed into the necessary fractions to permit picking, cleaning and other operations on the various fractions. In plants preparing by hand picking and cleaning, the raw-coal screen may also make the final sizes to be loaded.

The shaker screen, inclined at approximately 15 deg and with a crank or eccentric drive providing a stroke of around 6 in and a speed of 100 to 120 strokes per minute, is the common type of raw-coal sizing device. It is receiving increased competition, however, from vibrating screens, usually of the mechanical type.

A major difference between the two types of screens lies in the fact that the shaking unit also can be employed to convey and distribute the products, including provision for hand picking, as in plants preparing by hand picking and screening, where one shaking unit, with decks and extensions as necessary, can size the coal, provide facilities for picking, and distribute a number of sizes to their respective loading booms and chutes. If the unit is inclined at the usual angle, lengthening it out requires more headroom. This, among other reasons, resulted in the development of the level shaker with differential-motion drive to move the coal along the unit. A second difference between the two types of screens is the fact that the vibrating type, though it cannot do conveying, provides higher capacity in a given space in many instances. Degradation with either depends upon type of coal, type of screen and method of operation.

The flexible-arm or Parrish-type screen, usually operating at 150 to 185 rpm, 5- or 6-in stroke, 2- to 5-deg slope, is another form of shaker. However, its major use is more for final sizing and dewatering, especially in the anthracite field, where it is widely used for this purpose. Laminated-plastic hangers are now used on such screens instead of boards (*Coal Age*, September, 1955, p. 67). Advantages include longer life, no change in length and better screen action.

In addition to shakers and vibrators, simple raw-coal sizing may be accomplished by the bar or gravity screen, though its accuracy is not as good as the shaking or vibrating types.

With the growing trend toward mechanical cleaning, the raw-coal sizing screen is more and more being called upon for a rather simple separation of the raw feed into two or three fractions. Where this is the situation, the shaker can be a rather short machine. This situation has favored the rise of the vibrator in raw-coal screening also. Even where only a certain fraction of the coal is mechanically cleaned—screenings, for example—or only a certain size or sizes are treated—nut and pea, for example—the simple two- or three-product shaker may be employed with further raw-coal sizing allocated to vibrating screens. This, in fact, is a growing practice at bituminous plants, even where everything, or everything up to, say, 6 in, is mechanically cleaned, particularly if the plant is designed for treating several size fractions in different cleaning units.

SCREENING FACTORS

In addition to inclination, speed and length of stroke (or amplitude with vibrators), some of the factors affecting screening results are:

1. Depth of bed. Since screening can be accomplished only when the smaller sizes work their way down to the plate, depth of bed, in conjunction with size of opening and square footage of screening surface, is a major factor. With large openings, depth of bed may be greater. With smaller openings, bed depth must be reduced or the area of screen surface must be increased. Time also is a factor, though the opportunities for increasing it are somewhat limited and where it is increased degradation and breakage tend to increase with it.

2. Degradation. As previously noted, time is a factor in degradation. Narrow shakers also tend to increase degradation, and there is a major increase when more screen surface is provided than is necessary to accomplish the desired separation.

3. Wear. Heavy loads, coarse material and the possible presence of considerable rock are factors in wear on raw-coal screens. Among the answers for vibrating equipment is heavy alloy wire or alloy plate. On shakers, types of plate used to reduce wear include cast manganese.

Hand Picking

PURPOSES:

1. Impurity removal.

2. Improvement of appearance.

3. Production of a separate fuel grade.

From the standpoint of impurity removal, hand picking normally is effective only on coal 3 in or larger in size. Hand picking for impurity removal may also be extended to improve appearance by removing off-standard material. In addition coal cleaned mechanically or otherwise may be picked before loading to remove wood chips, stained pieces and the like. Here, the operator must balance any gain in realization resulting from improved appearance against the cost of such picking, which is high.

Where bony by itself or in combination with good coal is fairly high in percentage, some operators use pick-

Results," *Coal Age*, April, 1950, p 80.

thus avoid the ensuing drying and

launders of the free-discharge type.

ing as a means of removing this material, which then is crushed and sold as a power-plant fuel.

Under reasonably good conditions, and where the impurity content is high, one picker can remove as high as 6 tph. Under average or poor conditions with a lower impurity content, production may drop to 1 to 2 tph. This relatively low production at rather high cost is in part responsible for the trend toward crushing everything to, say, 6 in, and conversely toward raising the top size mechanically cleaned up to 6 to 8 in, and more recently up to 12 to 14 in.

Hand picking can result in a substantial loss of coal values unless provision is made for treating the pickings. The usual practice is to crush the pickings and run them to mechanical cleaners if used. If mechanical cleaners are not used, pickings, as previously noted, may be crushed and loaded as power plant fuel, especially if there is a percentage of high-Btu bony present for an added incentive. Of course, big lumps may be split or broken by the pickers themselves to salvage the coal, though this is an expensive procedure in view of present-day labor costs.

PICKING EQUIPMENT

Picking facilities include belt and apron conveyors, shaking tables and, occasionally, chain conveyors, the latter normally being employed only under special conditions and where the impurity problem is a minor one. All conveyor-type units lend themselves to combining the table with the loading boom.

The flat-topped apron conveyor and the shaking table best meet the major goal of removal of impurities without lifting or other handling beyond sliding the material removed to the discharge point. Other types of conveyors normally require skirtboards over the rollers or along the edges and thus necessitate lifting each piece to remove it.

The flat table may be a part of the shaking screen or may be separate. When separate, the table normally is sloped at about 5 deg and is operated at 150 to 160 rpm, 4- to 5-in stroke, crank or eccentric drive. Platform tables used in anthracite have a pitch of ½ to ¾ in in 12, with a 2-in stroke, 370 to 400 strokes per minute. The shaking table also lends itself readily to degradation removal by the installation of a screen section at the discharge end.

Some shaking tables have been equipped with partitions or deflection plates to further ease the load on the pickers by making it possible for them to do no more than push impurities out of the main stream to the center or pull them to the side, where the motion of the table carries the impurities to the discharge opening. Refuse chutes should be equipped with bars to prevent passage of pieces large enough to block the refuse conveyor.

In addition to elimination of lifting, factors contributing substantially to the efficiency of the picking operation include the following:

1. Depth of bed not exceeding the size of one piece.
2. Even flow with a speed of travel not over 80 fpm, and preferably between 30 and 60 fpm.
3. A width so that a man does not have to reach more than 30 in from the edge.
4. Height of approximately 32 in above the place where the man stands.
5. Spacing of at least 4½ ft between pickers, including the refuse chute.
6. Chute tops flush with table top and equipped with backboards to make it unnecessary for the picker to take his eyes off the table and permit him to use both hands.

Washing

Washing is a form of mechanical impurity-removal, or cleaning. Mechanical cleaning is growing because it has these definite advantages:

1. Mechanical cleaning is the only form of cleaning providing effective results on the finer sizes of coal.
2. A mechanical cleaner, properly adjusted and within the limits of its characteristics, provides the maximum in product uniformity—a major factor in market acceptance of the product.
3. Mechanical cleaning cuts labor cost per ton to the minimum and thus, compared to hand picking—at least in certain sizes—can sometimes reduce over-all preparation cost for a real cleaning job substantially.

What actually happens in the separation of coal and impurities is a complex and to some extent unknown physical process. Particle size and shape are involved, as well as the resistance of the medium used to movement of particles through it, and the fact that coal is cleaned as a mass of particles, with consequent interference between free movement of particles within the cleaning medium. In the main, however, separation is accomplished as a result of the difference in specific gravities of the coal and impurities in combination with the buoyant effect of the separating medium. In other words, where buoyance or its equivalent is present, the heavier particle will sink and the lighter will float, or the heavier will sink faster than the lighter particle.

The intensity of the buoyant force is expressed in terms of specific gravity. A high specific gravity means that a given separating medium will float a heavier particle. In other words, it is more buoyant. Starting with water, for example, specific gravity may be increased by adding a chemical to convert it into a solution, such as, the zinc chloride solution used in float-and-sink tests.

The majority of the coal to date, however, is cleaned by imparting an effect of higher gravity to water by setting it in motion—in other words, artificial gravity. The motion may be up and down, or jigging; continuous upward flow, as in classifier or upward-current washers; or stream, as in trough or launder washers. The goal in all is stratification of the raw coal with the heavy material, or impurities, on the bottom so that it may be split out by various methods. In addition to stream flow, motion may be used to facilitate stratification and separation, as on the coal-washing table. Air is substituted for water in pneumatic cleaners, and much the same principles of imparting an artificial gravity to it are employed.

True or artificial solutions, however, are increasing in use as separating media. The processes employing them are known by such terms as heavy media, dense media, heavy density, and so on. An example of the true solution used for some years is calcium chloride, normally accompanied by a slight upward current. For the most part, the effect of solutions is obtained by suspending sand or magnetite in water. Since the ideal condition for separation of coal and heavier refuse is a still bath of the proper gravity, and since the true or artificial solutions come closer to this condition, the sharpness of separation is increased—an added advantage where the separation problem is difficult.

A good indication of the difficulty of separation is the amount of material in the raw feed that lies close to the gravity of separation. In other words, the greater the percentage of near-gravity material, the more difficult, as a rule, the separation. A good indication of the efficiency of a cleaning operation is the quantity of misplaced material—coal in the reject and reject in the coal. To apply this measure, however, the inherent ability of the cleaner itself to separate coal and refuse must be known, since cleaners vary in their ability to achieve a given separation. Evaluation of this ability is a somewhat complex process, but methods of achieving it include those discussed in "Evaluating Preparation

Results," *Coal Age*, April, 1950, p 80.

In the main, however, if the washer is properly selected, is kept in adjustment, and is properly operated (see suggestions later in this section) it will provide the requisite separating efficiency. Basic in selection is detailed knowledge of the characteristics of the constituents of the feed. First of all the sample must be representative of what the washer will be called upon to handle. Then screening, sink-and-float testing, and construction of washability curves will show what can be accomplished under what might be called ideal conditions. Where it is evident that the problem may be difficult and the maximum in efficiency is desired, it may pay to wash sizable tonnages in pilot equipment or actual going plants to check test results. The results of washing a new coal may also be predicted by mathematical or statistical methods, such as that described in "How to Predict Results of Washing a New Coal," *Coal Age*, June, 1952, p 98.

WASHING PRACTICE

Factors in the application and operation of washing equipment include the following:

Size Spread in Feed—Certain types of washers require a rather small range in the size of the feed. Examples include the mechanical jig, classifier-type units, and certain washers using heavy media. The emphasis in design in recent years, however, has been toward equipment that will handle a rather large range of sizes—for example, the air-pulsated jig and the usual heavy-media equipment. The latter, incidentally, is now offered for handling a top size of feed ranging to 12 to 14 in.

Even where the washer is designed to take, say, all coal from 6 in down to zero, and can frequently do a good job on all the fractions in such a feed, some compromise must be made. In other words, somewhere along the line, the separation efficiency is less sharp—perhaps at the fine-coal end and perhaps at the coarse, depending upon washer design and adjustment. Consequently, if tonnage is fairly high and a sharper separation is desired throughout, the practice is to install separate units for the coarse and fine fractions—for example, one for 6x1 or 4x1, and a second for 1x0. Where the equipment requires a closely sized feed, the only out is to install separate units for each fraction it is desired to clean.

By-Passing Fines—Fine coal, say ¼ in or less, may be by-passed around washing equipment for several reasons: (1) to keep it out of water and thus avoid the ensuing drying and handling complications, (2) to permit more efficient operation of washing equipment installed to handle a rather wide size range, and (3) because of the problems involved in mixing of fines with medium, such as, sand and magnetite. The fines may be subjected to further treatment in other units or other types of equipment or, if both their quantity and ash content are not too great, may be mixed back into the washed coal.

Uniform Feed—A uniform feed, both in quantity per hour and in impurity content, adds measurably to the efficiency a washing unit can reach. The best method of attaining uniformity in quantity is the installation of some form of surge hopper or bin, plus a mechanical feeder, ahead of the washing unit. Attaining uniformity of impurity content is normally achieved by some form of blending equipment, as discussed previously in the Preparation Guidebook. Overloading should be guarded against particularly. While many washing units have a fair margin of excess capacity, overloading to any considerable extent is almost inevitably followed by a sharp decline in cleaning efficiency and in uniformity of product.

Feed Conditioning — Prewetting either in the feed chute or on special prewetting screens facilitates separation when the material reaches the washer, and consequently is finding increased use. Conditioning also is mechanical in nature. The feed, for example, should be uniform across the width of the washing area. Also, under certain conditions, particularly if prewetting is not employed, provision should be made for getting the feed quickly into the bath and to prevent clotting or travel enmasse, increasing the difficulty of separation.

Proper Adjustment — Maximum washing efficiency does not come automatically with the installation of the equipment. Consequently adjustment is a necessity—and it is necessary to keep a constant check on performance and readjust from time to time as changes warrant.

FINE COAL WASHING

Since mechanical cleaning of the finer sizes, say ¼ in or smaller, presents added difficulties and brings in different factors, special equipment is being increasingly employed for this purpose, although, with proper modification, conventional equipment can be and is used for fine coal. The special equipment includes tables (some designed, however, for top sizes up to 1¼ or 1½ in), upward-current classifiers (also offered for larger sizes), and launders of the free-discharge type.

Other equipment applied to fine-coal cleaning on occasions includes centrifuges and cyclones. Thus, for example, if clay particles or other impurities are concentrated in the lower size range, say 48M, they, plus also the coal in this range, may be spun or centrifuged out through the screen or the cyclone orifice. If the coal loss is not excessive, good results may be attained with certain types of coal.

FROTH FLOTATION

As coal and refuse particles get smaller and smaller, their ability to move as desired through water or other washing medium becomes less and less until a point is reached where separation cannot be accomplished on the usual basis. The practical line of demarcation is somewhat indefinite, although the minimum so far suggested for heavy media, for example, is 1 mm, with ½ mm as a possibility. At that point, somewhere around 10M or less, a different principle of separation must be employed to get maximum efficiency with reasonable capacity.

Flotation achieves these goals by adding a reagent to water and then inducing the formation of bubbles. Refuse particles will not stick to the bubbles but coal particles will and are carried to the top of the bath and removed for subsequent dewatering, or other treatment, and loading or mixing.

Facilities involved in flotation normally include a thickener or hydraulic classifier to size the feed, remove oversize, and so on; reagent feeders and conditioners where the reagent and the coal pulp are mixed and "conditioned"; and the flotation units themselves. The flowsheet also may be modified to include, for example, roughing cells preceding the final treating cells, retreatment units for a coal or primary tailing product from the primary bank of cells, or other modifications.

Air Cleaning

The basis of cleaning with air is substantially the same as for cleaning with water or other mediums (see preceding section). Air, however, eliminates or reduces the drying problem, although it involves a dust-handling problem similar to the water-handling and clarification problem involved in wet washing.

Air cleaners normally operate on a fairly closely sized feed and, as with water, the feed should be uniform in quantity and as nearly uniform in im-

purity content as possible. Moisture variations are particularly troublesome in air-cleaner operation, in addition to the effect—usually less severe—of high surface moistures.

Present practice in eliminating the effects of high moisture and lack of uniformity in table feed is to pre-dry, and a number of plants recently built include pre-drying equipment of the heat type. At the same time, if total moisture in the mine product normally is high, the operator gains the sales advantage of a minimum moisture content in the shipped product. Increased moisture in the raw product, incidentally, reflects the growing use of water at the face.

The majority of the air cleaners installed today operate on coal ½ in or less in size, though larger coal is treated. From the standpoint of the drying problem, washed coal over about ¼ or ½ in may be dewatered sufficiently for acceptance without special equipment—at least in many instances—which is in part the reasoning leading to the installation of combination wet and dry plants. And if mine conditions or mining practice make drying of fines desirable, it may be accomplished to the advantage of the air-cleaning process by pre-drying as previously noted. Normally, 2 to 2½% surface moisture in ⅜- or ¼-in coal is about ideal for air-cleaning efficiency.

Since air-cleaning equipment normally is highly sensitive, care must be devoted to adjustment both in installation and in operation. Air supply and distribution are the major factors. Continuous observation of the products is recommended.

Most air cleaners now installed are three-product machines, and thus normally provide a middlings product for retreatment. The coal in this middlings production and retreatment is maximum efficiency in separation with minimum loss of coal values. Dedusting to remove up to 50% or more of the fines—usually 48M—adds significantly to normal air-cleaning efficiency.

DUST COLLECTION

Every air-cleaning plant should be provided with an adequate and efficient dust-collecting system—not only for better operation but to prevent the emission of large volumes of dust into the air. Equipment for dust collection includes the following:

1. Large expansion chambers into which the dust-laden air is routed to permit settlement. However, such chambers can trap only the larger particles. Smaller baffled units are employed, however, for scalping ahead of other equipment such as cloth collectors.

2. Cyclone collectors. These centrifugal units are a popular means of removing dust from air. Since single units handling large volumes are less efficient because of reduced air velocity, multiple and tandem units are offered, raising separation from, say, 85 to 95%, up to 98%.

3. Turbo-centrifugal collectors. Turbo-type units, usually termed "clones," offer the advantage of smaller size as a general rule. Like the standard cyclones, they are relatively inexpensive to buy, are easy to operate and are low-maintenance units.

Even at 98% separating efficiency, the quantity of very-fine dust that can still escape to the atmosphere can run up to several tons per day. To trap the most of this remaining fine dust, cloth or bag-type and wet-type collectors are employed.

Of the cloth-type collectors, the bag type was one of the first to be installed at coal-cleaning plants, normally with a shaking device to remove the accumulated dust. A more-recent development is the cloth-screen collector, which provides larger capacity per unit of space occupied, is easier to inspect and maintain, and is provided with an improved cloth-shaking device. To prevent interruptions while the dust is being shaken off the units, dual-unit, or continuous cloth collectors may be installed, the air being directed alternately from one to the other.

Exhaust operation of dry-type equipment keeps the dust within the ducts and equipment in case there are leaks. Disposing of the dust requires care to see that it is not again dispersed when it is being dumped. One method is to run it into a final wet-type unit to convert it into a paste or slurry. Acid, abrasion and the like are factors to be considered in the operation of cloth-type filters, and require special cloths and other measures to get normal life.

Wet-type collectors include the tumbler; a combination of turbo-centrifugal unit and water sprays; and the hydrostatic. All have the advantage of high capacity in relatively small space, in addition to a high separating efficiency as a result of the use of water, particularly in the tumbler and hydrostatic units, where the dust-laden air is passed through a water bath. Both units have no moving parts.

Various types of dust-collecting units may be used alone or in combination—for example, cyclones followed by cloth collectors or wet units.

Retreatment

PURPOSE: Increase the ability of the washer to do a sharp separating job by relieving it of part of the load, particularly where the percentage of near-gravity material is high and consequently the cleaning problem is more difficult.

Steps in the retreatment of coarse coal are as follows, starting with a product from the primary washer draw or a special middlings draw:

1. Preliminary screening of the product at 2 in or other limit.

2. Crushing of the oversize to the screening limit to release the impurities.

3. Recirculation of the crushed product to the washer or to a separate retreatment unit. Separate retreatment units are employed where several units handle primary cleaning or where, even after crushing, the recirculated product contains considerable material close to the washing gravity.

With the smaller sizes, particularly less than, say, about ¼ in, where crushing is often less effective as a means of releasing the coal values, the entire draw product may be recirculated or retreated in a separate unit. This is particularly true in air-cleaning coal under approximately ½ in.

The value of this method of enhancing cleaning efficiency and reducing coal loss is evidenced by the increasing use of separators designed to produce three products: clean coal, middlings and refuse. This has been particularly evident in cleaners of the heavy-media type.

Salvage

PURPOSE:—Reclamation of coal that otherwise would be lost because it never gets to the preparation plant, or because the preparation system is set up to reject it without an opportunity to get it back.

Examples of salvage operations include the following:

1. Crushing and washing of pickings, either in regular or special units, to save coal values.

2. Picking out, crushing and loading separately for steam coal a bony product that might otherwise go to refuse.

3. Processing of roof brushings, track cleanings and the like to recover a regular or a steam-coal product. As an example, one plant producing metallurgical coal set up fa-

cilities for treating top brushing, which included a rider seam, the product being used for steam raising. Normally, the production of such material should be sizable to warrant separate facilities.

Another form of salvage, widely practiced in anthracite and to a limited extent in bituminous is reworking contents of old refuse banks and silt ponds or dumps.

Salvage operations ordinarily are carried on with conventional screening, crushing and cleaning equipment. Exceptions include the use of rock-type screens and crushers, and extra-large draws on cleaners where mine material or pickings containing large percentages of rock are processed.

Clean-Coal Sizing

PURPOSE: Separation of the product of cleaning or other processing operations into the final or semi-final size group for loading plus additional treatment of a certain size fraction. This treatment may include rescreening, crushing and rescreening, and so on, plus mixing and blending, discussed in later sections of this Guidebook.

Clean-coal sizing, or classification, is handled by both shaker and vibrating equipment, the latter having made substantial gains in this field as well as in the field of raw-coal sizing. Certain factors involved in clean-coal sizing are substantially similar to those in raw-coal sizing. In addition, accuracy becomes vital, not only because of its effect on the buyer but also because inaccuracy can materially affect realization by putting larger sizes into smaller. This in turn brings in questions of plate and cloth wear, blinding, and so on. Also, screening should be done to keep degradation in the process to a minimum.

ACCURACY FACTORS

Aside from moisture and blinding, accuracy involves time the coal is on the screen surface, and also cloth or plate wear. Time on the screen brings in the question of breakage, or degradation, which increases with increased screening time, though, as in anthracite, the hardness of the coal may permit a longer retention time without increase in breakage. Of course, other things being equal, sufficient time must be provided to permit the smaller sizes to work down and be separated out, and in turn this brings in the question of bed thickness. It should not be excessive if good screening is desired, and the smaller the opening the less the bed thickness should be if excessive length of screen is to be avoided. Where one of the products is screenings and the feed to the unit includes all sizes up to lump, depth of bed should not be more than 4 to 6 in, and screening efficiency and capacity may be increased by placing a large-hole relief screen over the slack section.

The relative ease or difficulty of screening a certain feed at a certain size, which in turn is one measure of the screen area necessary for accurate separation, reflects in the main the quantity of near-opening material in the feed. If there is a substantial percentage of material at or slightly larger than the opening size, particles smaller than opening size find it more difficult to work down through the bed of near-opening material, and also there is a greater chance that particles only slightly undersize will be carried beyond the screening surface before they have an opportunity to go through. The difficulty increases as the size at which screening takes place decreases.

SCREEN WEAR

Plate, cloth and wire wear reflect load, screening time, abrasive nature of the material, corrosion if the water is acid, and the material used in the screen. Where plain-steel plate is employed, increasing the thickness is one way of offsetting the effects of wear but brings in a significant decrease in screening efficiency. Consequently, operators turn to bronze and alloy steels, with stainless coming rapidly to the front in recent years for the smaller sizes. However, as a general rule, stainless life must be 10 times plain-steel life to justify its use for wear-resistance alone, and therefore bronze or other alloys are favored for heavy plate. With round-rod or wire screens, or with special-profile bars, wear is largely on the top and consequently the period of reasonable accuracy is materially lengthened.

Small-opening punched plate must be relatively thin, both to facilitate the punching operation and because excessive thickness, as previously noted, affects screening efficiency. Consequently, additional support is required to prevent sag and wear. Bars under the plates are the preferred method. An alternative is the Peristertread screen—a stepped-type unit in which the risers provide the extra support while the screening is done on the treads. Bars or other supports also are installed under the cloth on vibrating screens for the same purposes.

Elongated openings frequently are employed instead of round or square. Among the goals are: (1) increased screen capacity, (2) reduced blinding and (3) less breakage with friable coals. However, replacing conventional screens with long-opening units, with no change in the effective width of opening normally increases the size of the through product. In other words, it enlarges the effective opening.

A special form of screen is the lip type, usually with a greater width at the lower end. It provides a tumbling effect and this together with the type of opening, normally results in an increase in capacity of up to double or more. At some plants, this characteristic has resulted in installation of lip screens to offset a condition of chronic overload. Incidentally, overloading severely affects screening efficiency. For maximum accuracy, feeders or other devices should be provided to insure uniformity in rate of feed to screens.

Use of elongated, lip and similar screens brings in the factor of separation by shape as well as by size. Consequently, the products are quite different in character, with considerably more flats in the underproduct with the elongated-opening units.

Excessive flats may be considered a detriment in coal for domestic use. Anthracite is confronted more with this problem than bituminous. Flats may be picked out by hand or, where the quantity is large, mechanical pickers may be employed. These may consist of angles with a gradually increasing opening from feed to discharge end; small-diameter motor-driven rolls (several side by side); and special punched plate with narrow slots into which flats will slide but not the normal lumps.

BLINDING—CAUSE AND ELIMINATION

Blinding in coal screening occurs with all sizes but is particularly annoying and most affects efficiency with the smaller material. Blinding reflects in the main the percentage of particles near the size of the screen opening and especially, as the size of the coal decreases, surface moisture.

Additional factors tending to increase blinding include overloading and the presence of clay and shale mud. As a rough rule, a surface moisture of 6% will result in complete or nearly complete blinding at separations of ¼ in or smaller. At 2% or less, little or no blinding occurs.

Aside from blinding, moisture also tends to increase the inaccuracy of screening by causing small particles

to stick to larger pieces. Where washing is done, one of the functions of sprays on classifying screens, in addition to opening up and agitating the bed to facilitate separation, is washing the fines off the large pieces and through the screen.

The building up of a film of moisture and packed fine material is held to be the major cause of blinding in fine-coal screening. Time is a second major factor. Rust and corrosion with plain steel also can cause major blinding difficulties, especially after the screen has been idle for a time.

Electrical heating is rapidly growing as a means of preventing blinding of screen cloth. Other methods applying to cloth, plate or both, include:

1. Alloy metals which resist wetting and film buildup.
2. Use of plate, wire and cloth impervious to or less subject to rusting and corrosion.
3. Use of large openings, though this brings in the risk of throwing more oversize into the through product.
4. More screen area or a lower feeding rate with higher moisture.

More fundamental, perhaps, are mixing and blending to achieve uniform surface moisture or predrying of moist or wet material.

Screen Heating—Heating cloth electrically is rapidly growing as a means of preventing blinding. Most screen manufacturers are now in position to offer designs applicable to practically all types of screens. In addition to eliminating blinding and its attendant effects, including the necessity of increasing screen opening, heating also offers two other advantages:

1. Increased screen output—up to 50% or more.
2. Longer screen life—up to 4 or 5 times in some instances. Also, some operators have found that they can get increased life with smaller wire and less costly cloth.

Cost of equipping a screen generally ranges from around $800 for a screen of 20 sq ft up to $3,000 for 96 sq ft. Cost of power in many installations is 0.3 to 0.4¢ per ton of feed to the screen. Power demand reflects the screening problem and the screening problem and the size of the heating unit, which ranges from 10 to 30 kva. Heating, however, like other methods of preventing blinding, will not prevent wedging of near-size particles in the cloth nor clogging when the depth of the bed on the screen is greater than recommended practice.

DEGRADATION REMOVAL

Screening out of small pieces resulting from breakage in processing, sometimes called rescreening, can take place at convenient points in the operation. Usually, however, it is done immediately ahead of the loading boom or chute, generally by a separate section of screen in the sizing shaker or in the chute leading to the boom. Where scraper-type booms are employed, they may be fitted with a fixed screen near the end, the fines dropping through to the lower strand for return to the slack or screening circuit. And where coal is loaded by chutes from shortage bins or pockets, fixed sections of plate may be installed in the chute bottoms for degradation removal.

Dewatering And Drying

PURPOSES:

1. Reduction of moisture in the final product and enhancing the benefit to the consumer, particularly in the industrial category, by raising Btu content, reducing freight cost, or better fitting the coal for such uses as the production of metallurgical coke.

2. Elimination of freezing difficulties.

3. Preparing the coal, by such methods as predrying, for added efficiency in screening, air cleaning and the like, while at the same time securing Benefits 1 and 2.

Because the surface area on which moisture can collect increases rapidly with reduction in size, dewatering presents a greater problem with fines. As a rough rule, natural drainage will reduce the moisture on coal above ½ in and perhaps down to ¼ in to a point where there will be little or no freezing except in very severe climates. However, it may be desirable to reduce the moisture still further for the reasons set out at the start of this section. Below ½ or ¼ in, freeze prevention requires specific dewatering methods and equipment.

NATURAL DRAINAGE

Equipment employed in dewatering by natural drainage includes hoppers and bins; inclined and horizontal conveyors with screens in the bottom; perforated bucket elevators; and fixed screens. Fixed screens in flumes from washers to classifying screens, in fact, are widely used for unloading a large part of the water.

The fixed-screen principal for unloading or reducing excess water has been developed into special types of units both here and abroad. The launder screen recently developed for anthracite is made by placing 6-in-high partitions every 6 in along a chute or launder pitched at ¾ to 1¼ in per foot. Screen cloth is tacked over the compartments, which are drilled in the bottom to receive pipe bushings. Only a small percentage of the water and fines is removed in each compartment, resulting in more-even water distribution over the entire screen surface. Also, the bed is maintained in fluid condition, resulting in high screening efficiency.

A combination of "partitioned" and "radial" screens is used aboard and is now offered in the United States for preliminary dewatering of minus ¼-in coal prior to centrifuging (*Coal Age*, September, 1953, p 95). High efficiency with high capacity are claimed for the combination. Belts, as at one U. S. plant, may be used for removing a portion of the water by natural drainage. The belt may be humped in the center, or may be inclined with the coal placed on the side to permit the water to run back over the tail pulley.

For coal larger than ¼ or ½ in, dewatering by natural drainage is quick and complete, and the product, as noted, normally will not freeze unless the cold is severe and lasting. Where the finer sizes are involved and freezing is a consideration, the problem becomes more difficult. However, natural drainage of coal as fine as 1/16 in and 28M to surface moistures of 10 to 12% is being achieved with flotation coal.

The method followed by one anthracite producer, as an example, involves siphoning water off the tops of loaded cars and special caulking of the doors to facilitate draining through the bottom. The process is helped by the flotation reagent remaining on the coal, which facilitates runoff and acts to retard freezing in cold weather.

MECHANICAL DEWATERING

Omitting such processes as thickening and the like (see later section in this Guidebook), mechanical dewatering, frequently set up to complete the job in one pass, is done by screens, centrifuges and various forms of filters, the latter including the high-frequency electrically actuated vibrating type. With all, the dewatering process, as with fixed screens, normally involves producing a through product which must be loaded wet, discarded or treated by other means.

5. Suspension, in which the coal

the product is loaded without further

Over and through products from re-

Some special forms of mechanical dewatering include squeezing flotation coal on a belt conveyor by means of and idler-pulley.

Shaker Screens—Conventional shakers of course accomplish dewatering, but when dewatering is the specific goal the tendency is to go to special screens, usually flexible-board-hung or supported and operated at speeds of 150 to 400 rpm, with short throws of around 1 in. Anthracite shakers intended for both dewatering and sizing tend to operate at nearly conventional speed and stroke but with only a slight inclination, usually ¾ in per foot. For dewatering only, the speed is increased to 200 to 400 rpm and the throw is cut to 1 to 1½ in, especially for the smaller buckwheats.

Plate or cloth may be used in dewatering the larger sizes, and plate also is employed for a substantial portion of the smaller sizes in anthracite. In bituminous, however, when dewatering at, say, 28 mesh, the tendency is to use cloth, rod or wedge wire.

When used for dewatering, the shaker-type screen normally will reduce the surface moisture of sizes above approximately ¼ or ⅜ to 5% or less. When dewatering smaller sizes at, say, ½ mm or 28M, surface moistures of as low as 3% have been obtained, but the range usually is 5 to 10% and higher.

Vibrating Screens—The use of vibrating screens for coal dewatering has shown a major increase in recent years, partly reflecting their higher capacity. Both the conventional and special types are employed. One class of special screen is the flat or upwardly inclined type. In both instances, one result of the design is longer retention and greater agitation of the coal to increase the dewatering action. Another class is provided with dams to hold the coal on the screening surface for a sufficient period to insure maximum water removal.

Dewatering results reflect size of coal handled. Where the average size of the feed is around 5/16 in, a surface moisture of 5% normally can be attained, and in many instances much less. Final moisture increases with reduction in size up to 25% or more with, say, 28 or 48M material.

Centrifugal Screens—Now being offered for both dry screening and dewatering of the smaller sizes, the centrifugal screen provides results down to as low at 2 to 3% for coal approximately ¼ in in size in some instances, and normally around 5%.

Scalping Service—All types of screens and natural-drainage units may, of course, be used to scalp off part of the water before the coal goes into centrifugal or heat-drying equipment. And by the same token, the feed to screens may be scalped by settling tanks and similar facilities, thus again relieving the burden on the following units and raising their capacity and efficiency.

Centrifugal Driers—Centrifugal driers commonly used in coal preparation are usually divided into the screen and solid-bowl types. A new unit being offered in the United States includes a "rapper" or "bumper" to facilitate travel of the coal down the screen. Centrifuges normally operate on coal less than ½ to ¼ in in size and provide surface moistures of 5 to 7%, sometimes higher and sometimes lower depending upon the size and other characteristics of the feed. Unit capacities range from 20 to 75 tph, as a rule. Coal loss in centrifuging, again depending upon size consist and character, generally is 20 to 30% of the feed, sometimes less and sometimes more.

Centrifuges may be employed for the complete dewatering job. However, there is a tendency to use the centrifuge as a scalping unit ahead of heat-drying equipment, thus simplifying the heat-drying job.

Filters—With the increase in pressure to reduce stream pollution, and also as a result of the growing use of other types of mechanical dewatering equipment producing effluents containing fine material, there is an increased trend toward the installation of filters of the continuous-vacuum type. As a corollary, a solid-bowl centrifuge especially designed for the service, known as a "polisher," is used for the same purpose.

Filters receive feed from settling tanks and thickeners, directly from wash-water sumps, and as effluent from other types of mechanical dewatering units. Common combinations are a centrifuge and a polisher, a thicknener and a vacuum unit, or cyclones—single-or two-stage—and vacuum equipment. For typical flowsheets, see section on "Water Handling." With the vacuum type, flocculation of the fine-coal particles by means of caustic starch or some other agent increases filter capacity and reduces moisture in the final cake, which may be loaded directly or, in some instances, heat-dried alone or in combination with larger sizes.

Final surface moisture of the filter product is held to reflect largely the moisture in the feed, the percentage of minus 200M material and the ash content of the dried product, though feed moisture apparently is less of an influence than the other two factors. Depending upon percentage of fines and ash, surface moisture in the product ranges down to as low as 15% and up to approximately 30%, with some exceptions both above and below. For a complete discussion of selecting and operating dish-type filters, reloading factors affecting filtration rate and moisture removal, see *Coal Age*, January, 1955, p 76.

HEAT DRYING

Heat drying is about the only way to get surface moistures of as low as 2 to 3% consistently, particularly with the finer sizes. In this process, the coal is subjected to hot gases at temperatures slightly above the temperature at which volatile matter is distilled off of the coal. Time is a major factor in preventing distillation, or cooking, of the coal and consequently the aim is to keep it as short as possible, though longer periods are possible with reductions in temperature.

Types of heat driers used in coal mining are:

1. Rotary, with either inner and outer shells, or an outer shell with lifting vanes inside.

2. Screen, involving a reciprocating screen as the carrying medium. In most instances, the gas is pulled down through the bed and the drying action is of two types; evaporation and, to some extent, mechanical as a result of the screening action and the scrubbing action of the gas. When the gas flow is interrupted by an appropriate valve and then is resumed, squeezing also takes place. As the coal gets finer, evaporation becomes relatively more important, and consequently, fine-coal screen driers are designed for longer coal retention as a rule. New designs include a step between the two screens to turn the coal over.

Depending upon size of the unit also the size of the coal, capacities of screen-type driers normally range from 25 to 125 tph of dried product.

3. Cascade, in which the coal flows in steps down through a vertical shell, resting for an interval on each shelf or step in one type and on a bottom shelf in another.

4. Conveyor or carrier, in which the coal is moved through a hot-gas chamber on a perforated carrying strand or a wire-mesh belt. One type provides two stages of drying with both up- and downdraft gas flows, the down being the second stage and designed to permit maximum mechanical dewatering through the wire-mesh belt. The coal bed in the second pass also acts as a filter to catch dust from the first pass.

5. Suspension, in which the coal is introduced into an upward-flowing stream of gas. In one type, the coal is placed in the gas at the bottom of a drying column. Drying takes place almost instantly and the coal is separated out in a cyclone collector equipped with a rotary discharge valve. In another type, the coal flows down over the flights of an inclined conveyor and at the same time is moved sideways to the discharge point. Housing design is such that only the smallest particles escape from the chamber. Both driers are widely used for the finer sizes of coal.

Dust Suppression—Dust is a problem with practically all heat driers, and particularly with those handling the smaller fines. Cyclones are the first line of defense and may be supplemented by bag-type collectors, wet collectors and water-spray systems (see section under "Air Cleaning"). High temperatures and high moistures in the spent gas have militated against the use of bag collectors in some instances and resulted in adoption of wet or wet-and-dry (tumbler-type) collectors. The problem of disposing of the collected material has been solved in at least one instance where water-spray equipment was installed by cleaning it in flotation equipment and dewatering it on a vibrating screen.

Crushing

PURPOSE: Conversion of unwanted or slow-moving natural coarse sizes into smaller sizes desired by the market, as distinguished from crushing for process purposes, such as middlings retreatment.

Although crushing or breaking for market purposes can take place in the preliminary processing, as in reducing the top size in the mine-run feed to a certain dimension, the majority involves specific sizes after hand picking or other cleaning, and the goal usually is the production of stoker or other smaller sizes. An exception is anthracite, where practically all of the breaking is done in one or more stages before the coal goes into the cleaning units.

In bituminous plants, a favorite place for cleaned-coal crushing equipment is between the top and bottom strands of the mixing conveyor. This permits a wide flexibility in the size that may be run to the crusher, and also provides a convenient means of getting the crushed product back to the loading point, especially when the product is loaded without further sizing or other treatment.

Crushing may be—and frequently is—a part of a breaking and rescreening cycle for the production of double-screened stoker or other sizes, such as pea (see "Rescreening").

A major goal in clean-coal crushing operations—or, in preliminary breaking for the same purpose—is reduction to the proper size without excessive production of fines. Crusher design is one answer, and types and models now available permit good attainment of this objective. Operation is another answer and, among other things, involves stage crushing with rescreening between each stage. Some plants use as many as three or four crushers in series with vibrating screens between to unload the fines, which otherwise would result in increased grinding and pulverizing.

Flexibility in sizes shipped may involve considerable labor and loss of time in varying crusher openings. New models provide gear mechanisms for attaining such changes quickly and while the crusher is in operation.

Rescreening

PURPOSE: Production of additional and sometimes special sizes not normally provided by the regular sizing equipment.

The growth of the domestic stoker was in large part responsible for the growth of rescreening in the bituminous field. With a longer size list, anthracite, in contrast, had no need to change its practice, beyond doing additional crushing, to satisfy stoker customers. Making bituminous stoker normally involved at least dedusting or the removal of fines under, say, ¼ in. Also, many mines going into stoker had the problem of making a product with a top size of ¾, 1 or 1¼ in out of, say, 2-in screenings. Thus, rescreening received a large part of its momentum and the process then was broadened to provide what might be called specialty sizes for other purposes.

The vibrating screen, normally receiving its feed from the main sizing shaker, is the most-used type of rescreening unit in the bituminous fields. Air also has been used for dedusting at, say, 48M, in making the smaller stoker sizes. Rescreens also are quite commonly hooked up to receive material from cleaned-coal crushers when the natural output of the mine is not sufficient to meet stoker and other specialty demands. Over and through products from rescreening may be sold as separate grades but more commonly are run into slack and screenings shipments for industrial purposes.

Mixing And Blending

PURPOSES:

1. In blending, to achieve a high degree of uniformity of ash, sulphur and other constituents in the finished product. Blending is done mostly where metallurgical coal is involved and, as previously noted, is accomplished largely at the raw-coal end. However, some metallurgical plants also blend the cleaned product a second time before loading.

2. In mixing, to provide sizes better tailored to the needs of the consumer.

Most of the mixing is done on the old reliable mixing conveyor. Unless crushing is introduced into the circuit, the mix is a natural one—in other words, the sizes in the mix are present in the percentages they naturally come from the final sizing screen.

"Prescription" mixing is a relatively new method of achieving a size consist in line with the customer's desires. A major advantage is that the consists can be absolutely accurate and also absolutely uniform from day to day or shipment to shipment.

Prescription mixing normally is limited to the smaller sizes designed for industrial or domestic-stoker use. It involves placing the various sizes in separate bins. The sizes may be as they naturally come from the sizing units, or they may be produced in part or entirely by preliminary crushing and rescreening facilities. Mixing normally is achieved by feeding the sizes onto a gathering belt ending in a boom section. The rate at which the sizes are fed out of the various bins establishes the percentages in the mix. This rate may be adjusted by adjusting gate openings, but is considered less accurate than special feeders equipped with variable-speed drives.

Dustproofing

PURPOSE: Preventing the emission of objectionable volumes of airborne dust at the point of consumption by making dust and breakage resulting from handling and storing stick to the larger pieces.

The principal materials used for

dustproofing coal are oil, calcium chloride and special chemical compounds, usually containing calcium chloride with other substances added. Calcium chloride and other chemicals and materials, including cornstarch and molasses, paper-making by-products and so on, pick up water from the air and thus provide a moist surface to which the dust adheres. Corrosion-inhibitors may be added to the chemical-type dustproofing agents to prevent possible attack on metal firing equipment and coal-handling parts.

Spray oils for dustproofing are available in a wide range of characteristics to fit the job being done. Equipment for applying them includes both heating equipment for spraying hot, and high-pressure atomizing, or "cold-oil" equipment for spraying cold. With the hot-oil systems, the oil-carrying lines may be paralleled by heating lines carrying steam or hot oil to keep the oil at the proper temperature at the point of application.

Quantity of material necessary to achieve a desired degree of dustproofing depends upon both the size and type of coal being treated. Since the treatment is a surface job, and the surface to be treated increases as the size of the coal decreases, more material must be applied to the finer sizes. Porosity and other mechanical characteristics of the coal also influence both quantity and type of dustproofing material. With some very porous coals for example, good treatment with an economical quantity of petroleum-base material requires going to a very-high viscosity to prevent absorption of the material into the interior of the coal. Most of the high-volatile coals, however, may be treated satisfactorily with oils having a viscosity of around 200 deg.

Application—For maximum effectiveness with a minimum quantity of material, dustproofing material should be applied while the coal is in the air. Use of properly designed hoods prevents waste and insures maximum treating efficiency. Normally, such hoods are placed at the ends of loading booms or chutes, but they may also be placed over conveyors and other equipment, particularly those handling the larger sizes. The proper design of nozzle and the proper temperature at the point of application are key factors in the use of hot oil, and nozzle design is likewise important with other types of material to insure good treatment with minimum material quantities.

Regulation of material flow to the flow of coal may be accomplished by such steps as paddle-controlled valves at the ends of booms and chutes. The position of the valve is controlled by the thickness of the coal stream and in turn increases or decreases the flow of dustproofing material, preventing both overtreatment and undertreatment.

Freezeproofing

PURPOSE: Elimination of the labor trouble and adverse consumer reaction involved in the freezing of moist or wet coal in severe weather.

Where heat drying is not the practice and mechanical drying does not provide sufficient moisture reduction to prevent freezing, the coal may be treated with chemicals or oil. Such treatment usually is required with slack, screenings and other small sizes. The need for treatment is affected not only by the climate encountered but by industry custom and customer preference. Since anthracite, for example, has been shipped wet for many years and consumers have become accustomed to the situation and many are prepared with the necessary thawing equipment, there has so far been little stress on freezeproofing in that industry.

Salt and calcium chloride, usually applied dry, are the two main chemicals used for freezeproofing. The quantity depends upon the expected temperature and the moistness of the coal. For calcium chloride, the Calcium Chloride Institute offers the following guide:

	Lb CaCl per Ton at Specified Temperatures, Deg. F		
Moisture	+32 to +15	+15 to 0	0 to −15
3%	3.0–4.5	4.5–6.0	6.0–7.5
6%	6.0–9.0	9.0–12.0	12.0–15.0
9%	9.0–13.5	13.5–18.0	18.0–22.5

Chemicals may be thrown into the car by hand or may be dispensed by mechanical feeders into the coal stream as it is loaded. The latter normally provides more uniform and more accurate treatment.

Oil treatment, using the normal spray oil, will retard or prevent freezing if there is no great excess of water. Used crankcase oil or a similar type also has been sprayed on the interior of cars to prevent coal from freezing to the metal and thus making it easier to unload since, in some instances, the freezing is limited to a crust a few inches thick and the car can be unloaded cleanly if sticking on the sides and bottom can be prevented.

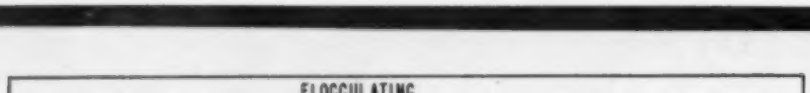
Loading

Anthracite is loaded into railroad cars almost entirely from storage pockets, reducing the number of loading tracks to one or two for many plants. Early bituminous practice was to provide a track for at least each major size, though a growing number of bituminous plants are providing pockets for certain sizes—usually stoker or other sizes in the smaller range. Loading of two cars on the same track also is practiced to some extent at certain bituminous plants by conveying one size to a pocket above or below the regular loading point.

Where only one size is produced, or where storage bins are provided for one or more additional sizes, loading of entire shift's run of railroad equipment can be done with the new elevated shuttle belt without moving a single car once they are set in by the railroad. One late shuttle-belt installation (*Coal Age*, March, 1953, pp 94-95) is based on elevated narrow-gage track 760 ft long with a 380-ft-long 30-in reversible belt conveyor on wheels operating on it. The belt is between two tracks accommodating 20 cars each, and coal can be loaded either way at either end of the belt by pairs of discharge chutes and diverting gates. One man at a push-button station controls belt operation and the operation, of the elevating conveyor feeding coal onto it from the preparation plant.

Booms have long been used to lower the coal into railroad cars with a minimum of breakage at bituminous plants, and there is a tendency to extend their use to the smaller sizes, particularly stoker, though the chute still is the popular loading device for slack, screenings and other smaller sizes. Belt, apron and scraper-type booms are employed, with shaker booms as an added starter. The first two lend themselves to hand picking on horizontal sections. The third can be equipped with degradation screens, the breakage being returned to the mixing conveyor or other point by the bottom strand.

Mechanical retarders provide positive control of car movement in loading, and there is a growing trend toward the use of motorized equipment, including special hoists which permit pulling a car back uphill if desired, or moving it back and forth several times to load the coal in layers. The latter, among other things, reduces size segregation and improves appearance. Provisions for changing cars without stopping equipment include pantograph diversion chutes on booms



combined with the cleaned coal, or

which automatically come into position as the boom is raised. Other types of diversion chutes provide the same benefits with booms and also with chutes.

TRUCK LOADING

Loading of trucks requires somewhat different practices. It is possible to load trucks over the tracks or by chutes brought out from the plant but this, among other things, makes it impossible to service trucks except when the plant is running. Consequently, the usual practice is to provide bins or pockets for sizes sold to truckers. Spiral lowering chutes prevent breakage in filling bins holding the coarse sizes, and degradation in handling through the bins is removed by fixed screens in chutes, or by small shakers or vibrators.

Late truck-loading plants include, in the bituminous field, a multiple-silo installation in which the coal is distributed to the pockets by a pivoted elevated belt, which is swung on a curved track from one pocket to the other for filling purposes. Trucks are loaded through chutes.

In the anthracite field, a new six-bunker plant is designed so that all operations are conducted by two men and accurate dispensing of orders is controlled by pre-setting dials to control flight feeders delivering at rates up to 5 tpm (*Coal Age*, January, 1954, pp 68-69). The dials are calibrated to tenths of a ton and trimming to adjust weight is seldom necessary. Coal is delivered to the truck plant by two 24-in belts housed in corrugated pipe, and is distributed to the bunkers by two shuttle conveyors.

Tramp-Iron Removal—Removal of tramp iron is handled at a number of plants, even though all sizes are washed, by suspended magnets or magnetic pulleys at the point the raw coal enters the plant. If washing or removal in the raw-coal stage is not practiced, iron removal should be done in the loading stage, especially with coal designed for stoker use. Facilities include magnets designed for use in the bottoms of loading chutes, as well as other types of units.

Degradation Removal—See "Clean Coal Sizing."

Water Handling

Questions involved in water handling at plants cleaning by wet methods include:

1. Fresh water supply and treatment.
2. Clarification and recirculation.
3. Final disposal where circuits are or can not be closed.

Makeup water requirements vary with the type of circuit. In a fully closed circuit, where sprinkling at the face results in an average of 5% surface moisture on the raw coal, which is the same as the average for the shipped coal, it can be seen that fresh water cannot be added. Normally, the only clear-water applications would be on pump glands and certain other essential applications. In an average plant, under these conditions, makeup water might well be only 50 to 75 gpm. In an open circuit, it might well be several times that minimum.

Sources of makeup water are:

1. Deep wells.
2. Surface water from lakes, ponds and streams, or from reservoirs made by dams to catch surface runoff.
3. Mine water, if available.

Water from deep wells normally can be used without treatment. Mine water, on the other hand, may be quite acid, though there are exceptions. Surface water may or may not be acid, and may at times be contaminated by mud. Some authorities hold that the pH value of the water in the plant circuit should be between 8.0 and 8.5.

Other operators, however, feel that slight acidity is not objectionable. However, if the water is very acid, treatment with lime or soda ash is in order. Treatment permits plain steel, for example, to be used instead of alloys, resulting in substantial savings in cost of equipment and materials, in replacement labor and in shut-down time. Even if the makeup is only mildly acid or neutral, acid may build up in the recirculated water and need treatment for that reason alone. Automatic equipment is now available for water treatment efficiently and at minimum cost.

Unless there is an assured minimum flow adequate for plant need at all times, storage should be provided to tide the plant over periods of reduced flow. Impounding dams, if possible, and artificial ponds and storage tanks are among the answers. In hilly country where dams are not feasible, wood-stave or other tanks are employed by some operators to store up to, say, ½ million gallons. With any type of system, a small surge tank should be provided at or in the plant to receive the fresh water, which usually is added—at least in part—through clear-water sprays on the clean-coal classifying screens.

HANDLING WASH WATER

Practice in the operation of wet plants is more and more toward either closed circuits or a minimum of bleed. Objectives in closing the circuit include (1) elimination of discharge to streams, (2) reducing makeup water to that required for glands and other essential uses, (3) recovery of coal and (4) recovery of medium. As a corollary of closing, it normally is necessary to remove at least part of the solids, especially if clay and mud are present, since the change in apparent gravity of the water can—though not necessarily does—materially affect washing results.

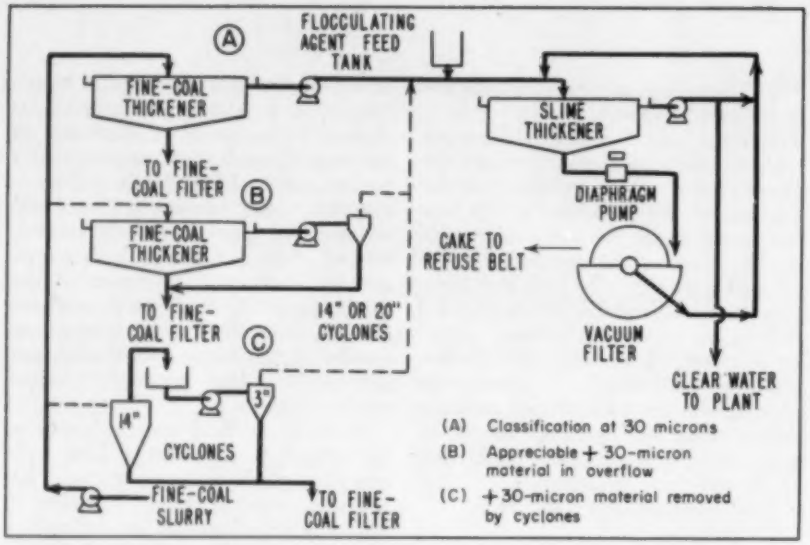
Practice and field custom, however, may result in dumping of large volumes of wash water. It may, for example, contain large volumes of high-impurity fines that are difficult to clean. And under some conditions it may be necessary to feed excess fresh water into the system for essential services, even if it is not introduced to rinse off clean coal and improve appearance.

Settling tanks and cones have been widely used to reduce the solids content of wash water for recirculation or disposal, and also to permit, if desirable, recovery of at least part of the fines. Thickeners operating on the same general principle are growing in use for the same purposes. The extent of clarification depends upon the size of the material, the time provided for settlement, and the degree to which disturbance can be reduced.

Types of thickeners depending upon natural settlement include the circular units, some provided with rising current of water; rake units; and spirals. Flocculation of the material promotes settlement, and some types of thickeners are built to permit flocculation along with settlement.

One of the simplest, though not necessarily the cheapest, methods of handling wash water is to run it to a pond. Properly designed, such ponds can provide sufficient settling and clarification to meet pollution standards, in addition to providing relatively solids-free water for recirculation. However, any fines that reach the pond, either directly from the plant or via sludge tanks, cones, thickeners and the like, are lost from the circuit and, if of saleable quality, cannot be recovered for all practical purposes. Also, sludge ponds cost something to build, and if of limited capacity must be cleaned out from time to time. Consequently, there is a trend toward extracting the solids from the waste water or bleed before discharging it to the pond.

Equipment employed for such solids extraction, in addition to that previously listed (used either alone or more frequently with that in the following



SOLIDS REMOVAL from wash water by flocculation and filtration.

list), includes both hydraulic and nonhydraulic classifiers, cyclone thickeners and filters of various types. These latter include centrifugal and vacuum units, with the most-popular form of vacuum equipment the disk filter. Cyclones and filters, as noted in the succeeding section, are an increasingly used combination.

SOLIDS AND SLIME REMOVAL

Aside from completely closing the circuit, methods of reducing the load on sludge ponds, in addition to sludge tanks, cones, thickeners and the like, include, as previously noted, cyclones, classifiers and filters. Bleed or waste water, for example, may be run to a cyclone installation (*Coal Age*, December, 1954, p 62), followed by a vibrating screen to receive the underflow—dewatering it and discharging it to refuse or clean coal. The screen underflow may be recycled to the cyclones, while the cyclone overflow, containing minus 200M, goes to the pond. The 200M, however, stays in suspension longer, and to reduce the possibility of an overflow containing a heavy percentage of such material, flocculation may be the answer.

Three variations in a slime-removal flowsheet (*Coal Age*, January, 1955 p 76) involving flocculation and complete closing of the circuit are shown in an accompanying illustration. The goals are economical operation and removal of the solids so that they can be handled the same as any other solids, whether coal or refuse. Variation A is recommended where the fine-coal circuit includes a gravity classifier effectively classifying at 30 microns; Variation B, where gravity classification is such that an appreciable quantity of plus 30-micron material is found in the overflow; and Variation C, where the equivalent of two-stage cyclone concentration is employed.

Closed Circuits—Three water-handling systems based on filters for final recovery of the solids are shown in the accompanying illustrations. Suggested for use where clay slimes are not excessive and closed-circuit operation can be obtained by filtration, or where the large slime fraction is bled off to a sludge pond, the three systems involve:

1. Cyclone classifiers in conjunction with gravity classifier or thickener delivering thickened underflow for filtration.

2. Cyclone classifiers in conjunction with filters. The two-stage system shown may be employed (1) where solids under 100M are too high in ash to be included in clean coal and (2) all underflows from both stages are filtered as clean coal. A buildup of minus 100M in the circulating water is prevented in both instances.

3. Thickeners and cyclones for preliminary concentration. Better filter operation is one of the advantages.

Medium Recovery—All heavy-media plants using magnetite include equipment for its recovery and return, with or without densification, to the cleaner circuit. Sometimes, only one magnetic separator is employed, and sometimes two are employed in series, the second acting as a polisher. On occasions, also, the magnetic separators may be preceded by thickeners. Densifiers normally are used for further thickening of the magnetite before return to the sump for recirculation. Tailings from the separators may be wasted, combined with the cleaned coal, or subjected to further cleaning before return to the plant output.

Water Circulation—Head tanks with automatically controlled pumps provide a uniform head on washing equipment, with consequent increase in the efficiency of separation, particularly with jigs. Provisions for coping with water and solids include the proper types of metals or the proper linings in pumps, as well as plastic, rubber and other special forms of pipe for certain applications to resist both wear and corrosion. Rubber-pinch and orifice-type valves solve some of the flow-control problems and provide good regulation, in addition to reducing the valve maintenance problem.

Handling of casual and spillage water is simplified by proper design of the basement floor, which should be equipped with drains leading either to the pond or to a recirculating-water sump. Cleaning up by washing down is facilitated by such construction, and, as indicated, the coal may be returned for re-processing.

Sludge Recovery

PURPOSES:

1. **Water clarification.**
2. **Recovery of saleable material.**

Normally, water clarification and the recovery of fine coal, whether called sludge, slurry or some other name, go hand in hand, although if clarification only is the goal, the material may only be routed to the refuse bank, particularly if it is refuse in fact. However, the percentage of material finer than, say, 10 or 28M, may be substantial at many plants and may warrant recovery for its own sake, especially if it can be shipped without further processing. Even where processing is required, the quantity and character of the finest may warrant a substantial investment, particularly if clarification also is required or is desirable.

The equipment for recovering sludge from wash water, as noted in the preceding section, includes: settling cones and tanks, and thickeners and filters, along with hydraulic and nonhydraulic classifiers and cyclones. Cleaning equipment includes flotation units and special fine-coal washers, followed by normal dewatering and drying.

The preceding envisions recovery of the sludge as it is produced in the plant. Another form is recovery from old silt or sludge ponds or banks, an increasing practice in recent years.

Recovery equipment includes conventional shovels and also floating dredges. At some installations, the final step consists of drying. A modification, where the nature of the material warrants, is centrifuging to throw out the fine impurities and then heat drying. Where cleaning is considered desirable, a number of large plants have been built for conducting this operation by froth flotation, which may be followed by heat drying.

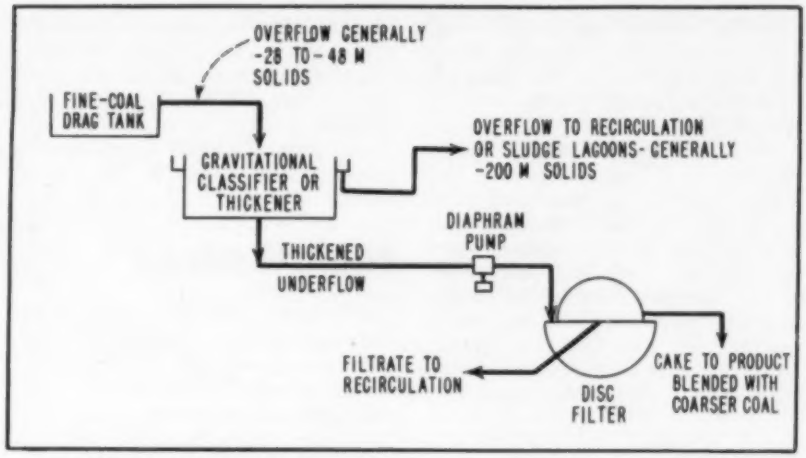
Refuse Disposal

The dump truck has taken over a large part of the refuse-disposal job in the coal industry today. Its advocates cite low cost and maximum flexibility, especially where it does not have to surmount too-heavy grades. The aerial tramway lends itself not only to disposal in what might be called normal territory but also to taking refuse across hills into neighboring valleys and the like. The side-dumping or revolving larry, in addition to ordinary situations, also is used to build out from hilltops or hillsides from bins fed by belt conveyors, tramways and the like.

Some pumping of refuse is done, though the question of taking care of the water to prevent stream pollution comes in. In some instances, it has been possible to pump into old mines or worked-out sections. The pumps will handle rather large pieces but normally pumping requires crushing to a top size of 2 or 3 in. Even with other methods of disposal, especially where large mine rock is handled, it may be economical to crush with rock-type equipment, such as jaw or gyratory crushers. Easier handling, a more-compact pile and greater ease in maintaining a running surface where trucks are used are among the arguments in favor of crushing not only mine rock but also large refuse of any nature.

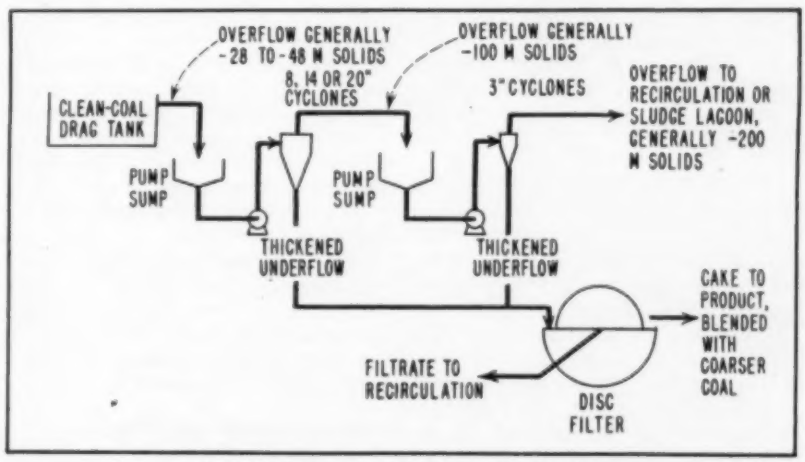
Where refuse output is large, and especially where trucks and similar equipment are employed, a bulldozer for spreading and compacting may pay off. Properly equipped, the bulldozer also may be used to shift track where larries are employed. A few refuse trucks themselves have been fitted with front blades or with special tailgates for spreading, particularly if the material handled tends toward the small side.

To save handling mine rock through the regular preparation refuse-disposal facilities, special rocker dumps may be installed, if conditions otherwise permit, to permit dumping directly from the mine cars onto and

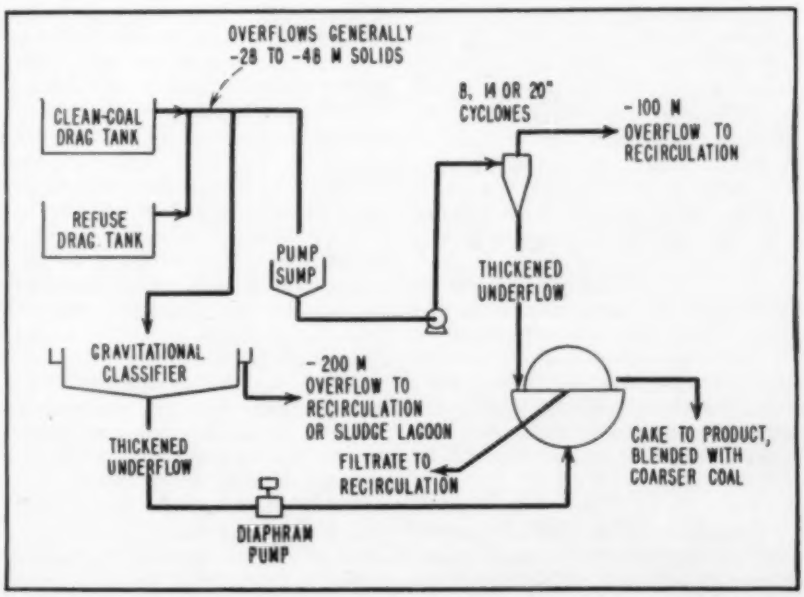


GRAVITY CLASSIFIERS or thickeners for preliminary classification.

Continuous Vacuum Filtration Systems



CYCLONES for preliminary classification.



GRAVITY THICKENERS and cyclones for preliminary classification.

over the bank for easy final disposal.

Prevention of firing of refuse dumps has been the subject of considerable research in recent years, and the spread of automotive haulage has made possible new and effective methods of piling, compacting and sealing refuse to practically eliminate firing. One method of layering, compacting and sealing against air is described in *Coal Age*, June, 1951, p 91. Development of the method also was accompanied by steps to extinguish an old fire by stepping, trenching and filling and covering with earth as conditions dictated.

Power

Voltage—Accepted voltage for most of the stationary motors in preparation plants is 440, leaving in most instances only the question of whether 2,300 v should be used for certain large units, as on pumps, crushers and the like. A rough rule is that motors of 100 hp and larger should be 2,300.

Transformer Location — Packaged substations with oil-filled transformers are available for outdoor service, with non-flammable units for indoor. Outside is the place for the transformer station if the highline voltage is over 10,000 and the reduction to 440 is made in one step. If the supply voltage is less than 10,000, the packaged indoor substation with non-flammable transformers is the general choice, principally because it can be placed closer to the center of the load.

Controls—Starters grouped in factory-assembled control cabinets are now standard for preparation plants. One central cabinet is satisfactory for a small plant, but a large plant may require cabinets at several locations to keep the motors reasonably close to the starters. Draw-type starters which can be pulled out for quick replacement are coming more and more into favor.

Dust is one of the major problems in location and operation of starting equipment. The best solution seems to be one or as few control rooms as possible made fairly airtight and fitted with blowers to maintain a slight positive pressure inside the rooms. Air forced into the rooms should be filtered.

Capacitors — The induction-motor load of the preparation plant produces a low power factor, which adds to the bill and heats conductors and motors. Capacitors should be installed in the plant to bring the lagging power factor up to unity. Theoretically, an appropriate capacitor should be placed at each motor. However, practical limitations of cost, space and maintenance generally make it advisable to group the capacitors in the control room.

Maintenance

PURPOSE: Efficient plant operation with no or a minimum of interruptions. A collateral goal is conduct of maintenance with a minimum cost for labor and materials.

Maintenance is necessary because of wear and corrosion inevitable in operation, and the effects of the elements, for example:

1. Rusting of the exterior and interior, including structural members and equipment, as a result of rain, snow and water.

2. Corrosion from acid water and, on occasion, from the gases given off by burning refuse dumps. Acid-water corrosion, of course, shows up most in washers, screens, tanks and other facilities exposed to water.

3. The effects of heat and gases involved in heat drying.

4. Wear from the handling of coal and rock.

5. Lack of lubrication, overloading and other abuse, faulty electrical service and the like, resulting in motor and machine breakdown.

MAINTENANCE FACTORS

All wear and corrosion, cannot, of course, be eliminated. However, consideration of the causes and their effects logically indicate the remedies which, in large part, are preventive in nature. In other words, use of the proper materials and proper designs when a plant is built, or when parts or sections are added or replaced in existing plants, are major factors in maintenance cost. These materials and designs include the following:

1. Location of heavy equipment, particularly of the rotating or reciprocating type, on or as near ground level as possible, cuts structural cost and reduces the effects of weight, motion and vibration.

2. Bracing, steel weight, balancing and damping to provide stiffness, reduce or eliminate unbalanced forces, and prevent the transmission of motion and vibration to the structure.

3. Use of protected steel and special roofing and siding materials, including asbestos-cement and aluminum.

4. Protective coatings and paints for steel exposed to rain, moisture, gases and the like. Paints and coatings normally, of course, are not for surfaces exposed to moving coal or rock, water carrying solids and the like.

5. Neutralization of acid water with lime or soda ash. Automatic feeding equipment now available facilitates this job. Frequently, neutralization will make it possible to get much-longer life from ordinary steel, saving both in material cost and replacement labor.

6. Use of corrosion- and abrasion-resisting materials for screens, chutes, flumes, water lines, pumps and so on, including plastic, rubber and asbestos-cement water lines and connections, and rubber-pinch and orifice-type valves. Stainless steel for bolts, for example, can solve some annoying corrosion problems in certain preparation applications.

7. Use of linings to resist wear and, with some types, corrosion. Examples include glass, tile and brick in chutes; and rubber, plastic, sand-cement and ceramic linings for tanks and cones. Entire loading pockets have, on occasion, been built of glazed tile to combat wear and corrosion. Another form of lining is special hard metal for conveyor bottoms. Hard-surfacing of wear points or the use of special wearing strips are natural accompaniments of the broad use of lining materials.

8. Use of totally enclosed, splash-proof and other special motors for dusty, wet and similar locations, plus moisture- and dustproof controls or the location of controls in rooms with blowers using filtered air and maintaining a slight positive pressure inside the rooms at all times.

9. Good lubrication with proper equipment and quality lubricants of the correct types applied at the correct intervals. Centralized automatic systems are growing in favor as a result of demonstrated benefits, and have proved their ability to handle even such difficult problems as underwater bearings in settling tanks.

10. Regular inspection and cleaning of preparation equipment. Cleanliness and good housekeeping for the plant as a whole naturally supplement these, and to facilitate housekeeping a growing number of plants are being equipped with hoods and covers for certain equipment connected to exhausting and dust-collecting equipment, plus vacuum systems for cleanup.

Actual conduct of maintenance is facilitated by plant design and maintenance tools and facilities. A design which provides adequate room around the various units eases inspection and cleaning, and makes repair and replacement easier when necessary. An

elevator in the larger plants, in addition to the usual cranes and blocks, facilitates moving equipment, materials and tools in and out. Monorails over centrifugal driers, screens, crushers and so on facilitate changing jackets, segments and other removable parts.

Electrical and compressed-air outlets at strategic points facilitate the use of power tools in maintenance. And, since welding and cutting play such vital roles in preparation maintenance and in plant changes, there is a real advantage in piping gas throughout the plant and having one or perhaps two or more electric welders at strategic points. Good lighting, in addition to promoting safety, facilitates checking on equipment operation, cleaning, and necessary repair and replacement.

Quality Control

PURPOSES:

1. Attainment of the desired preparation standards with a minimum of deviations and a maximum of efficiency.

2. Securing data on the quality of shipments for possible use in adjusting complaints and as a final check on preparation performance.

Control of preparation results starts, as indicated in earlier sections of this Guidebook, by such steps as blending, proper picking practices, uniform feed to cleaning units, proper adjustment of cleaning equipment, and so on. Checking on the results and getting records on shipments, the subject of this section, is largely a means of making sure that all the other steps are being carried out properly.

Checking and control measures are both visual and mechanical or chemical. With lump, for example, the bulk and weight of a proper sample, and the increased difficulty of getting a representative sample, make mechanical and chemical tests difficult, and reliance must be placed largely on visual inspection. In washing, visual inspection—by operators who know their business—of the feed and draw material can reveal changes in conditions immediately and permit adjustments to be made promptly, although this type of checking is subject to the normal human frailties.

Even with mechanical and chemical methods, the change in conditions takes place before the results are available, thus re-emphasizing the importance of adjusting operating conditions to provide the desired results as nearly automatically as possible. However, even though the data are obtained after the fact, mechanical and chemical tests are necessary to provide positive evidence of whether or not the desired results are being attained and permit adjustment if not.

Sampling—Where the tonnage is at all large and a careful check on quality is essential, one or more specialists should be charged with the responsibility of collecting samples. Depending upon the control setup, he also may run sink-and-float tests and prepare samples for more-elaborate chemical tests.

Number of samples and sampling intervals depend upon control and quality data required. Egg and lump —and perhaps nut and pea—may be sampled at longer intervals and perhaps only once a shift or longer. The problem grows more critical with the smaller sizes, especially where sales are made on a specification basis. As a result, many plants sample stoker and screenings, as examples, at intervals of as small as 15 min, while every hour is fairly common.

Automatic samplers installed at transfer points, especially for the smaller sizes, reduce the labor involved in sampling and tend to increase the accuracy. Manual methods include the car sample taken at a number of spots, but the trend today is toward cutting samples out of the coal as it flows into the car. A convenient method is to mount a narrow box of the requisite length and depth on a pivoted arm, which is swung through the coal stream at the specified intervals. Labor is saved and the sample tends to be more representative.

If the sample is intended for chemical analysis in the laboratory, time and labor can be saved by placing the preliminary sample-preparation equipment—crusher, splitter and the like—at or near the point the sample or samples are taken. As an example, some plants have provided platforms alongside the loading booms for sample preparation. Among other things, this permits running the coal left over after splitting directly to the car.

Test Procedure—Samples for checking cleaner operation normally are processed by sink-and-float. The equipment, which includes factory-made units designed specifically for the job, may be on the cleaning floor or at some other convenient location in the plant. The weight of the sink in a standard sample of cleaned coal is a working indication of how the cleaner is performing. The results also may be converted into fairly accurate ash figures by reference to a curve based on the average results of analysis of a representative number of samples, provided testing is carefully done and the character of the refuse is not subject to sharp fluctuations.

Checking the efficiency of washer operation also requires testing of refuse to make sure that coal loss is not excessive, and also of the raw feed to determine whether a change in its character will establish different limits on the results that may be expected or will necessitate readjustment to attain the original standards.

More precise results of course can normally be expected by laboratory procedure, although the time interval necessarily is longer. Equally or more important, the laboratory is the only means of attaining all the chemical and physical data on both processing results and the character of the shipped coal, including ash, sulphur, moisture, heat content, fusion and softening temperatures of ash, and so on. Also, the presence of laboratory facilities permits research into suggested changes in preparation procedures and forecasting of results. Therefore, more and more plants are being supplemented by well-equipped laboratories. An example is the subject of an article in the April, 1950, issue of *Coal Age*, p 90.

Laboratories normally are placed in separate structures although a few have been built in the preparation plants themselves. The added convenience is said to more than compensate for the necessity of careful enclosure to keep out dust and noise, and the cost of methods of insulating the laboratory from vibration and motion.

Sizing Control—Since the accuracy of screening can have a major effect not only on realization but also on customer acceptance, quality control must take in size checking also. Facilities will vary with the circumstances at the individual plants but they should at least include a test-screen unit, which may be purchased from various manufacturers.

Records—The type of records kept for operating and quality-control purposes should provide for putting down the data obtained in a form that will make it easily available to and usable by operators, supervisors and other interested persons. Graphic presentation by curves may be a part of the record system, and the data to be entered may include such things as valve settings on washers. For shipments, the record may show car number, size, ash, sulphur, heat content, moisture and so on.

The Maintenance Guidebook

THE MEANING of "maintenance" in coal mining has changed radically in recent years as a direct result of increasing wage rates, the rising use of machinery to offset these increases, and the change to the day-rate method payment, which increases the cost penalties suffered by the company when production is interrupted. Now, "fixing" a machine after trouble occurs, once the leading idea in maintenance thinking, has dropped to last place in the ranking of the three major objectives in maintenance:

1. Prevention of machine breakdowns. This normally is termed "preventive" maintenance but more properly might be termed "production" maintenance, since production and cost depend upon keeping the machine running at full capacity as much of the time as possible.

2. Improvement in machine condition, if possible, or at least preservation of original machine condition and capacity during its useful life, which life, on this basis, is determined by obsolescence rather than wear.

3. Repair after breakdown.

Breakdown Cost the Key

Prevention of machine breakdowns, or "production" maintenance, quite properly holds first place in organizing maintenance. The importance of this principle becomes apparent with a little study of breakdown cost. A loss of an hour's time, for example, can mean a wage outlay, with a 10-man crew, of approximately $25 for which no production is received. Or, looking at it another way, if the unit averages a ton a minute, an hour's delay would mean a loss of 60 tons, increasing the section labor cost per shift, depending upon travel time, 8 to 10c per ton in this instance.

The key is getting the maximum production for the money that must be laid out whether coal is run or not. Wages and salaries are the principal items, but overhead, power for pumping and ventilation, etc., must be included.

The "chain-reaction" principle also has become more and more a factor in maintenance thinking as machines have taken over more of the production load, as more and more productive capacity has been concentrated in individual units, and as the day-rate method of wage payment has become almost universal. Thus, for example, a fall on a loading station or a slide in a strip pit hurts much more now because of this concentration of production and because a much-greater part of the money outlay continues while production stops. Thus, maintenance becomes even broader in scope when keeping production machines running at rated capacity becomes the overriding goal, as it is today.

Getting Efficient Maintenance

Nothing being perfect, breakdowns and production interruptions cannot be completely eliminated, but they can be kept to a minimum by a reasonable expenditure of time and money. As an example, a month's report on six continuous miners working two shifts a day at one operation where tons per man average for the units ranged from 41.0 to 57.3 showed a breakdown total of 150 hr 29 min out of a total of 1,848 possible producing hours, or 8.2%.

But while keeping down time to a minimum is the major goal, a second one is conducting maintenance work with a minimum of manpower and materials.

What can be done in these and other directions to keep production interruptions to a minimum—and to do it at minimum cost—is the goal of the material which follows.

Reports And Records

PURPOSES:

1. Providing data on the causes of delays and time lost, thus permitting concentration where the greatest gains can be made.

2. Providing information on equipment condition as a means of forestalling breakdowns.

3. Providing information on the cost of repairs, overhauls and the like as a further check on whether proper operating and maintenance practices are being followed.

It might be said, in fact, that without proper reports and records, even though they involve paper work, no real progress can be made in maintenance. But while paper work is essential, careful study of the types and numbers of forms will reduce it to a minimum—and will make that minimum more valuable.

TYPES OF REPORTS AND RECORDS

Daily Delay or Operating Report—In breakdown prevention—the No. 1 goal in maintenance—the daily delay or operating report is a must. It shows what the mechanical and electrical failures were and how much time was lost with each. Also, these reports may

Maintenance Foundations

Delay Reports and summaries show what is happening and where to concentrate

SECTION FOREMAN'S DAILY DELAY REPORT

MINE _____ DATE _____

SECTION _____ CARS LOADED _____

FOREMAN _____ SHIFT _____

Type Delay	Time	Remarks

REPAIRS NEEDED _____

CONTINUOUS MINER TIME STUDY

Date _____ By _____

No. _____ Place _____ Shift _____

TIME LOST									Total Time Lost	Total Time Operated	Total Time
Shuttle Car	Bolting	Timbering	Moving	Breakdown	Power	Water	Changing Bits	Oil & Grease			
Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.	Hr. Min.

Progress: _____ ft. hdg. _____ ft. A.C. _____ ft. x.c. _____ ft. room

Total Feet _____

No. Trans Cars _____
No. Shuttle Cars _____
Approx. tons per car _____
Approx. total tons _____
Tons per man day _____

Report below only breakdowns:

No. Men		Time	Amount
_____	Foreman	_____	_____
_____	Operator	_____	_____
_____	Operator Helper	_____	_____
_____	Shuttle Car Operator	_____	_____
_____	Loader Operator	_____	_____
_____	Car Trimmer	_____	_____
_____	Others	_____	_____
		Total	_____

Cost Per Ton _____

Bolting: No. Bolts _____

No. Men	Classifications:	Time	Amount
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
		Total	_____
		Grand Total	_____

Operator: _____

CONTINUOUS MINER TIME STUDY

No. 1 _____ MINE

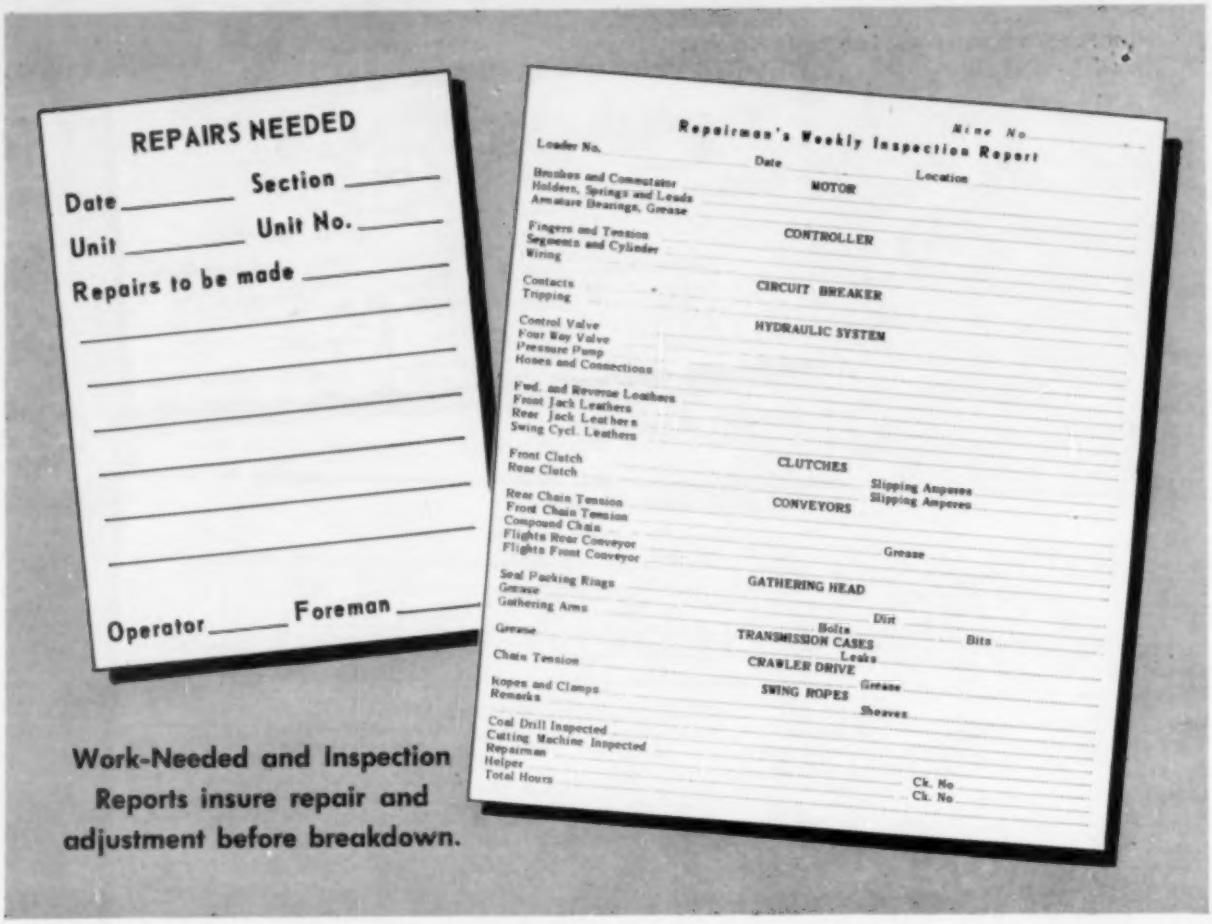
Month of _____, 19__ DAY SHIFT

Date	No. Men	Shuttle Car	Bolting	Timbering	Moving	Breakdown	Power	Water	Change Bits	Oil & Grease	Total Time Lost	Total Time Operated	Total Time	No. Feet Advanced	No. Shuttle Cars	Tons Per Car	Total Tons	Tons Man Day	Total Cost	Cost Per Ton	REMARKS
1																					
2																					
3																					
31																					
Total																					

No. 1 _____ MINE

Month of _____, 19__ NIGHT SHIFT

Date	No. Men	Shuttle Car	Bolting	Timbering	Moving	Breakdown	Power	Water	Change Bits	Oil & Grease	Total Time Lost	Total Time Operated	Total Time	No. Feet Advanced	No. Shuttle Cars	Tons Per Car	Total Tons	Tons Man Day	Total Cost	Cost Per Ton	REMARKS
1																					
2																					



Work-Needed and Inspection Reports insure repair and adjustment before breakdown.

be expanded to show other delays and their causes to permit appropriate action. Thus, they become running time studies of machine performance, and provide invaluable data for eliminating the causes of reduced efficiency.

The daily report may be rather simple, per the accompanying example, which concentrates on production and delays only. Or, as in the second example illustrated, it may include details on labor, number of roof bolts installed and so on. In this particular example, two of the items are tons per man and section labor cost, which can serve as a sharp reminder of the value of keeping delays to a minimum.

For top management, and as a running record of results, the delay reports should be combined into weekly or monthly summaries. To accompany the daily continuous-miner report illustrated, for example, a monthly sheet, also shown, pulls everything together in one place. With summaries such as this, it is easy to focus on trouble spots and determine, for example, if a new material, special repair skill or other steps are necessary.

Automatic records of operating and delay time are possible on certain types of equipment. Examples are swing recorders for shovels and draglines, and electric clocks hooked up with feeders in preparation plants so that they run only when the feeders run. Such equipment eliminates human errors in computing or entering lost time and, in the case of the feeder clock, permits checking on how the plant is doing at any time merely by a glance. Swing charts, on the other hand, permit detailed study of what has been happening if it should appear necessary.

Work-Needed Report — To attain fully the goal of preventing breakdowns, some form of reporting on work or adjustments required is a necessity. It permits reporting a part that seems likely to fail so that the necessary steps may be taken to repair or replace it on the next idle shift.

Work needed may be reported either on the front or back of the regular delay form, or it may be reported on a special form. Where it is entered on the regular form, special handling may be necessary to make sure that both the repair foreman and the superintendent, for example, get the data they need without delay. Or, the forms may be made out in duplicate or triplicate and routed accordingly.

Where separate forms are used, the original naturally goes to the repair foreman, with perhaps a copy to the superintendent. In some instances, the form includes space for reporting on when the work needed was done, with or without copy to the superintendent, as a further means of insuring that prompt action is taken.

Inspection Report — As a second means of preventing breakdowns, a number of mining operations have instituted inspection reports. An example is illustrated elsewhere in this section. The frequency of such reports can vary from daily to monthly or longer, with a week or a month as the most common. The reports are derived from special inspections of a varying degree of thoroughness, and normally involve going into certain cases and the like. In other words, the machine is given a more thorough examination than would normally be involved in a quick daily once-over. Inspections may be made by the regular section electricians or mechanics, or by special men from the mine or central shop. These men at the same time can make certain adjust-

ments and repairs, and can note larger jobs that may require taking the unit out of service.

Unit Cost Record—There is a growing trend toward keeping a complete record of repair parts and labor unit by unit. Labor in this instance normally means special labor beyond the usual attention given by the section mechanic—in other words, shop and special labor required for major repairs and overhauls. Paper work is increased but the accurate unit record provides, among others, these advantages:

1. Excessive expenditures may signal waste or loss of parts sent into the section for running repairs, as well as lack of lubrication, abuse of the machine by operators, and so on.
2. Rising expenditures may signal the need for overhaul earlier than normally scheduled to prevent excessive machine breakdown.
3. Consistently higher expenditures for one type of machine, compared to another of equal capacity, may make it desirable to standardize on the lower-maintenance unit, other things being equal.
4. Data on the value of special materials—for example, stainless steel—can be readily obtained to show if they are worthwhile or not.

For maximum convenience, unit cost records may be kept on cards designed for rotary or other quick-viewing files. The data for the records naturally comes from requisitions for parts and materials submitted by the foremen or other responsible officials, and from reports on parts used and labor expended by the repair foreman. Naturally, also, summaries of the unit records should be made at regular intervals—perhaps monthly—for the superintendent and other officials having jurisdiction.

Record Distribution—As implied in the preceding paragraph, reports and records can be fully effective only when they, or the data from them, are regularly routed to the responsible operating or maintenance heads. Thus, for example, the superintendent or other operating head should receive weekly or monthly delay summaries and unit-cost records. Distribution to other officials, including face foremen, may be helpful as an incentive and also to inform them when delays or costs begin to mount up.

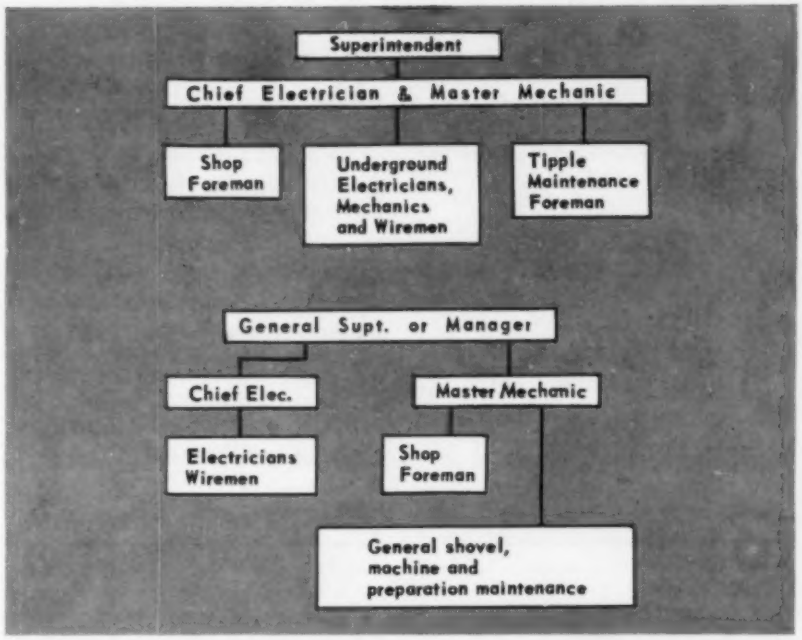
WHO SHOULD FILE REPORTS

The type of report will, in many instances, indicate who should file it—for example, a report on work completed by the repair foreman, or on lubrication by the head of the lubricating crew, if one is employed. Daily delay and operating reports may be filed by the foreman or the operator of the key machine, with some arguing for the machine operator since the foreman may not be with the machine at all times. Operator reports, if that is the system, naturally should be filed through the foreman, who will check and countersign.

Where several machines make up a unit, there may be a question as to whether reports should be required of the several operators—for example, cutters, shuttle-car drivers, etc. Among other things, such reports might be valuable by focussing operator attention on the need for good maintenance and care in operation. Practically, however, one report, especially if prepared by or with the cooperation of the foreman, usually can provide the necessary information.

Reports on work needed likewise may be filed by the operator, the foreman or the section mechanic, working with each other.

Whatever the number and scope of the various reports, the rule should be a practical system.



SHARED RESPONSIBILITY between operating and maintenance departments facilitates efficient maintenance.

Responsibility

Rather than emphasizing what any particular department should do, the goal in maintenance is the program—what it should be and what it should do. Once the program is fixed, the responsibilities of the operating and maintenance departments become clear. Under this approach, the responsibility for an effective maintenance program is one for the operating management, which also exercises the final authority.

But while final authority logically rests with the operating department, the cost, capacity and complexity of the new machines now handling coal production require additional skills and manpower to keep them running at rated capacity. Consequently, the responsibility for sustained production which only the maintenance department can discharge is increased. In other words, as a practical matter, production depends to a major extent on maintenance, and the maintenance department must be organized and staffed accordingly.

For an indication of how this works out at the face, the foreman has the responsibility for seeing that his unit is operated with a minimum of delays—in other words, that it produces at the maximum rate. Among the things involved are training of operators to prevent abuse and to induce them to take care of their machines, plus inspection of units and running repairs. The necessary special skills are provided by the electrician or mechanic, and the foreman looks to him for the prevention of mechanical and electrical delays, the maintenance of machine condition, and the quick effectuation of running repairs and adjustments. This illustrates the principle that though the operating department has the final authority the

What, Where and Who In Maintenance

FIRST ECHELON	
1. Inspection	Unit foremen
2. Running maintenance and repairs	Face or pit mechanics or electricians (greasing may be handled by greasing crews)
3. Equipment servicing	
SECOND ECHELON	
1. Major inspections	Master mechanic, chief electrician or maintenance foreman
2. Major repairs and replacements short of overhaul	Special task forces or "bull gangs"
THIRD ECHELON	
1. Major repairs outside of section	Maintenance head and shop foreman
2. Overhaul	Shop force

maintenance department is the key to sustained production.

Organization, Manning

Getting maintenance done promptly and effectively, as distinguished from organization of the staff, might logically be approached by considering the type of work necessary. This leads to the "three-echelon" system illustrated, which breaks down as follows:

FIRST ECHELON

Inspection and minor running repairs at the face or in the pit make up first-echelon work. Normally, inspection is conducted by the section or pit electrician and mechanic, along with the operators, and the same men handle running repairs and adjustments.

First-echelon work also includes servicing the equipment, such as, lubrication, checking and inflation of tires (trucks at strip pits and rubber-tired equipment underground), cable maintenance and repair, and other similar operations.

Typical setups for manning face maintenance are one mechanic or electrician for one or two units, underground, and one or more men for each major class of equipment in the larger strips—for example, (1) shovels and draglines, (2) drills, pumps and compressors, and (3) trucks, tractors, graders, etc. However, organization is subject to considerable variation, and at smaller operations, or at operations with certain types of equipment of a rather simple and rugged nature, running maintenance may be handled by one man or one man and a helper.

Whatever the type of operation, however, the basic principle is assignment of sufficient specialists to a unit or a group of units to keep breakdowns to a reasonable minimum, since overmanning, in maintenance as in other activities, runs up the cost in excess of the benefits in additional lost-time reduction.

SECOND ECHELON

Major inspections involving some opening of cases and enclosures, and also major repair or replacement jobs done during idle periods make up second-echelon maintenance. Part of this work, such as, inspection and replacement of certain units and assemblies, may be done at regular intervals, and part will be done when necessary to avoid a potential breakdown or take care of an actual one.

Such work normally falls to special groups, which may be: (1) permanent task forces or "bull gangs," (2) special groups of men normally employed in the underground or field shop—or perhaps the main shop, or (3) temporary groups made up by assembling the regular section or pit men on off-shifts or idle days. Similar task forces normally handle the maintenance of preparation plants.

THIRD ECHELON

Normally, third-echelon work involves complete overhaul of a machine on the basis of time, tonnage, yardage or hours worked. Underground units and small stripping units, as examples, normally are brought to the shop, or sent to an outside custom shop, for complete dismantling and rebuilding, and large stripping units are moved back from the face or out of the pit to prepared overhaul areas.

Aside from equipment, third-echelon work takes in such other activities as the repair of conveyor belts, large truck tires and similar items, for which some companies have special shops or shop sections. Others use custom shops or manufacturers' repair and service facilities.

Since overhaul, in addition to skill in dismantling and assembly, requires, as a rule, basic skills in metal-working and the like, and normally also requires bringing the equipment to the main shop or a prepared overhaul area, maintenance men handling this class of work are largely kept on it alone, though certain men occasionally may be sent into the mine or pit to handle certain face or field jobs. The number of men and the specialties involved again depend upon the situation at the particular operation or company.

Spare Equipment

PURPOSES:

1. Reducing the effects of breakdowns.

2. Permitting overhauls without production drops.

One method of alleviating the effects of major breakdowns is keeping spare units on hand, provided the cost of such spare units can be kept within reasonable limits. It is manifestly impracticable, for example, to buy two 30-yd shovels, one to substitute for the other when it breaks down. The goal here must necessarily be one of making sure that breakdowns are kept to the absolute minimum, and that the shovel be maintained in such condition that major overhauls are required only at rather long intervals.

With smaller units, such as underground loading machines, a much-greater opportunity exists for keeping spares on hand without excessive investment. General practice is to provide a spare for each 3 to 5 major production units, such as, loaders, cutters, continuous miners, shuttle cars, etc.

Basically, the number of spares depends upon conditions and particularly on the extent to which preventive maintenance reduces major breakdowns. Time necessarily is involved in getting the inoperative machine out of the way and the new one in, regardless of how close the spare may be. If breakdown time can be kept below that figure without exception, there theoretically would be no

need for spare units, except to maintain output during overhaul periods.

But since breakdowns have an annoying habit of causing lengthy delays, there is an opportunity for the spare units, and that opportunity increases as breakdown frequency and time increases. However, there is a drawback. Investment in equipment—and in parts and labor to take care of breakdowns—also increases. The conclusion is that preventive maintenance on the working units is the real goal, and will reduce the need for spare equipment and also the breakdown cost.

A second factor determining spare-unit practice is the overhaul schedule. With intervals of 6 mo to 2 yr on major underground units and on certain surface units, and with overhauls requiring up to a month or more, spares are a necessity if production is to be maintained at a certain level. Usual practice is to take an underground machine out of the section, or a small portable unit out of the strip pit, and send in the spare unit. Certain underground mines, however, follow the practice of keeping extra completely equipped sections, and transferring the crews for the overhaul period, on the basis that moving men is less costly than moving equipment.

Standardization

PURPOSE: Simplification of maintenance work, with consequent increase in efficiency, through keeping the types of units to be serviced to a minimum.

Standardization of mining equipment, of course, has its limits, and complete standardization would make it difficult to work in new types of machines and thus take advantages of their characteristics. But with fewer types of equipment, including components such as motors and the like, there is a much greater opportunity for learning all about the equipment and how to handle it. Also, repair-part inventories are reduced and the problem of receiving, storing and issuing parts is simplified.

Personnel Training

PURPOSES:

1. Instilling a regard for maintenance principles in supervisors and operators, thus reducing machine abuse and stimulating inspection and reporting of potential difficulties.

2. Increasing the skills and knowledge of the maintenance men themselves, with resultant increase in their effectiveness.

Training is used here in the broad sense of developing both a regard for the value of maintenance and a knowledge of basic principles, in addition to specific work designed to increase the skills of the maintenance men themselves.

Operating Managers and Supervisors—While they need not, perhaps, be required to take formal courses, particularly in the details of maintenance, operating managers and supervisors should know what good maintenance means and how to go about getting it—and also keeping it.

Operators — Here, again, formal courses may be impractical, but since a careless or uninformed operator can raise delay time and maintenance costs significantly, he also should be made aware of what good operating practices mean in both high production and low cost, and of what he can do to prevent machine delays and breakdowns. The logical men to provide him with the necessary information and skill are the foremen and the section or field mechanic or electricians.

Maintenance Men — At least two types of skills are necessary in achieving maximum results in maintenance, repair and overhaul. One type is the basic skill, such as, machining or welding. Three ways of obtaining men with such skills are: (1) hiring men already proficient, (2) hiring graduates of training courses, and (3) setting up company training programs, either conducted on company premises by company-employed trainers, or by outside training establishments to which the employees are sent.

A second skill is proficiency in diagnosing and taking care of trouble on specific equipment units, where a good knowledge of what the unit is and how it operates is imperative. If this skill is not already available, or if it is felt that it could be upgraded, sources of training include:

1. Factory instruction, either at the manufacturing plant itself or through service representatives visiting the mine.
2. Extension courses made available by colleges and universities.
3. Trade-school courses.

Even if only a basic knowledge of electrical and hydraulic principles was gained, the extra insight should result in a better electrician or mechanic, especially if it resulted in his taking more of an interest in his work because it was more meaningful to him.

Contract Maintenance

Since outside shops serving a region or a large part of the industry have an opportunity to install more facilities and employ more men with the necessary skills because of the larger volume of business, they are increasingly able to offer major-repair and overhaul advantages, especially to organizations not large enough to support full-scale facilities. Shops now in existence, along with facilities offered by equipment manufacturers, are set up to give speedy, efficient service in overhauling and repairing loaders, continuous miners, shuttle cars and other underground equipment, bulldozers, small shovels, engines and similar equipment for strip mining; plus conveyor belts, tires, motors and other components. Bit sharpening, drill sharpening and other service shops round out the list.

Even though they still may be large enough to support their own facilities, some companies prefer to use the custom shops and thus avoid having to build, staff and maintain their own shops.

Rated Voltage

PURPOSE: Preventing motor failures and cable damage by preventing excessive heating as a result of the excessive current which accompanies low voltage.

It is difficult to overemphasize the importance of rated voltage at the motor terminals as a factor in maintenance—and in unit production. DC motors, for example, tend to slow down almost in proportion to voltage drop, and slow-acting machines, plus frequent cable and armature failures, tend to result in don't-care operators.

When trailing cables or motor conductors are subjected to high current overloads—one result of reduced voltage—the resistance of the copper conductors increases, the cable drop rises, the voltage to the machine is further reduced, the machine automatically calls for more current with added heating, and the vicious circle continues—possibly to the point of cable or motor failure. Under extreme conditions, copper can be heated to 600 F or higher, at which point it will burn even if nothing else fails before.

As an example of what can happen, consider a 50-hp motor, 0.85 efficiency, served by a 1/0 cable 300 ft long and trying to do the same work at 270 and 180 v. The extra current loss in the conductors at 180 v could

approximate 0.4 kw. On this basis, the extra heat generated in 1 hr is equivalent to between 6 and 7 lb of coal. It is almost the equivalent of operating a household stoker inside a jacket of cable or motor insulation.

MAINTAINING VOLTAGE

Admittedly, the preceding is an extreme case, although not unknown in actual operation, where heat has been known to cause trailing cables to almost explode into flame. It points up, however, the need for maintaining rated voltage at machine terminals, especially in view of the higher horsepowers being crowded into motors used on face machines, and into others as well.

The causes of low voltage include:

1. Substations too far from the working face.
2. Excessive cable length.
3. Inadequate feeder and return capacity.
4. Cables too small.

In addition, excessive heating results from the following:

1. Layering on reels or in piles, decreasing cable rating because of inadequate air circulation.
2. Inadequate or no overload protection. Properly rated fuses or properly set circuit breakers should always be used.

Regular voltage checks therefore become a necessity in preventive or production maintenance, and may even warrant the use of recording-type instruments at strategic locations. Otherwise, the section electrician may well be charged with the responsibility for making regular checks. And to make these checks effective, a program of moving up substations and beefing up feeders and returns as necessary must be followed. This might well be the responsibility of the chief electrician, maintenance supervisor or electrical engineer.

Since even under the best of conditions, heat is generated when current flows in conductors, and the higher horsepowers now being employed in the same or only slightly larger space aggravate the problem, the best in motor and cable insulation should be employed, such as, asbestos-fiber compounds, silicone and the like. Blowing motors is a well-established method of keeping them cool in certain types of service, and cooling by water jackets is coming into the picture for certain motors subjected to the most-severe duty, as on continuous miners.

CABLE MAINTENANCE

Even with rated voltage, delivery of the necessary power to the operating machines usually involves a trailing cable of some type. Aside from low voltage and overload, the major causes of cable failure, particularly underground, are:

1. Excessive Tension—Install spring-type shock absorbers, keep proper tension on reel, adjust reel to prevent back spooling.
2. Mechanical Damage—Avoid running over cables, replace broken sheaves and guides, avoid pinching cable.

Additional data on failures and their causes appears in a comprehensive discussion of cable types and cable maintenance in the December, 1953, issue of *Coal Age*.

In the event a cable fails in spite of all precautions, reducing the time lost requires quick restoration of the service. Some ways of doing this are:

1. Use of compression connectors and special hand or power tools for quick connection of the power and ground wires to save time. Special portable welding equipment also is used to make splices electrically in the section (*Coal Age*, January, 1951, p 70).
2. Use of spare cables to permit quick replacement of the entire cable. An alternative with at least certain types of equipment is the use of sectionalized cables, which not only are easy to install but also lend themselves to the quick replacement of a new section for one that has failed.

Temporary splices should be kept to a minimum. One rule allows six, after which the cable is removed and sent to the shop for rebuilding by permanent welded or compression-connected splices and vulcanizing. Some mines remove the cable with a lesser number of splices. At certain operations where attendants are required at substations or other facilities, these men are provided with the necessary repair and vulcanizing facilities and take care of splicing, vulcanizing and other cable maintenance, thus saving the wages of a repair specialist.

Fault-Finding — Failures in long high-voltage cables, such as on strip shovels, can result in a long search for the trouble point, with attendant loss in production time. Electrical fault-finders now on the market cut this time loss to a minimum by giving a quick and accurate indication of where the failure occurred. Or, the mine can make its own (*Coal Age*, May, 1953, p 108).

Lubrication

PURPOSE: Providing at the right time, in the right place, and in the right quantity the proper lubricant necessary to provide the thin film that prevents bearing wear and consequent machine breakdown.

RESPONSIBILITY

Attainment of efficient lubrication requires acceptance of perhaps three responsibilities.

1. Selection of lubricants and lubrication equipment. This responsibility normally falls on the maintenance department, though the importance of lubrication might well warrant the employment of a lubrication engineer—at least where a company operates several mines and a large number of producing units. Sources of help in lubricant selection include lubricant suppliers and the engineers of the machine builders.

2. Establishment of a lubricating schedule. Scheduling, with attendant reports and records, is perhaps one of the most-vital elements in efficient lubrication, and here again the responsibility rests on the maintenance department or the lubrication engineer.

LUBRICANT APPLICATION

The third responsibility in lubrication is getting the job done, which responsibility may be placed on the maintenance department alone or may be shared by the maintenance department and the machine operators and/or section mechanics and electricians. The lubricating system varies with the type of machine and when and where it is used. The three general systems are:

1. Hand Lubrication. This usually involves grease guns or spout-type or other oilers for fluid lubricants. Where this is the practice, lubrication normally is handled by either the machine operator or the mechanic or electrician assigned to the machine or section, or by a special oiler, as with large stripping units. Lubrication can be combined with inspection and running maintenance, as with belt conveyors underground, for example.

2. Lubricating Trucks and Special Crews. Such trucks are used both underground and at strip pits. Hand lubrication may be desirable for several reasons, including low working height, cramped quarters, or the type of unit, such as, a belt conveyor. However, since individuals with other duties frequently are called upon for lubrication under this system, the chance of human error is greater. Hand lubrication also increases the chances of contamination, and may require stopping the units during the

SHOVEL NO. _____ **SMALL SHOVEL LUBRICATION RECORD** MONTH OF _____ 19

DAY OF MONTH	1			2			3			4			12			13			14			15		
AFTER INSPECTION OF LUBRICATION WORK IS COMPLETED, SHOVEL OPERATOR AND PIT FOREMAN MUST SIGN REPORT. IN ABSENCE OF PIT FOREMAN, LOADING FOREMAN SIGNS FOR LUBRICATION WORK COMPLETED USE CHECK (√) SIGN / SHIFT	12	8 am	4 pm	12	8 am	4 pm	12	8 am	4 pm	12	8 am	4 pm	12	8 am	4 pm	12	8 am	4 pm	12	8 am	4 pm	12	8 am	4 pm
HOURS OR MINUTES DEADHEADING																								
HOURS OPERATED LOADING COAL, ORE, ETC.																								
PARTS LUBRICATED PIT NO.																								
(1) Truck Frame and Propelling Machinery (Lower Works)																								
All Fittings Below Deck Lubricated																								
Circle Rollers Lubricated																								
All Cat Assembly Fittings Lubricated																								
Propel Bearings Lubricated																								
Open Gears and Sliding Surfaces Lubricated																								
Enclosed Gear Case Oil Level Checked																								
(2) Revolving Frame and Machinery Units (Upper Works)																								
All Fittings in House Lubricated																								
All Open Gears Lubricated																								
Enclosed Gear Case Oil Level Checked																								
Hydraulic Oil Level Checked																								
Gasoline or Diesel Engine Oil Changed																								
Light Plant Oil Changed																								
Electric Motors and Generator Bearings Lubricated																								
Flexible Couplings Lubricated																								
Air Compressor Oil Changed																								
Air Filters Cleaned																								
(3) Front End Equipment																								
All Boom Fittings Lubricated																								
Boom Support Cables Lubricated																								
Hoist Cables Lubricated																								
Open Gears and Sliding Surfaces Lubricated																								
Enclosed Gear Case Oil Level Checked																								
All Bucket Fittings Lubricated																								

(1) TRUCK FRAME AND PROPELLING MACHINERY

PARTS TO BE LUBRICATED:
- Drive Tumbler Shaft and Transverse Propel Shaft Bushings.
- Longitudinal Propel Shaft and Propel Brake Shaft Bushings.
- Center Pintle Thrust Washer Oil Pump (Note Instructions On Pump)
- Center Pintle Bearing Bushing.
- Take-Up and Idler Tumbler Bushings.
- Steering Clutch Shifter Collars.
- Steering Clutch Sliding Jaw Guide Bars.
- Propelling Bevel Gear Cases.
- Cat Side Frame Gear Cases
- Swing Rack Teeth
- Roller Track Bars.
- Roller Pins.

(2) REVOLVING FRAME AND MACHINERY UNITS (Upper Works)

PARTS TO BE LUBRICATED:
- Vertical Propel Shaft and Upper Propel Shaft Bushings.
- Propel Bevel Gears and Sliding Propel Gears.
- Hoist Pinion Sleeve Bushings.
- Hoist Gear.
- Drum Shaft Bearings
- Intermediate Shaft Bearings
- Intermediate Reduction Gear Case.
- Vertical Swing Machinery Gear Case.
- Vertical Swing Shaft Lower Bushing
- Electric Motors and Generators
- Hydraulic Pressure System
- Operating Lever Shaft Bearings, Bell Cranks.

(3) FRONT END EQUIPMENT

PARTS TO BE LUBRICATED:
- Boom Point Sheave Bushings.
- Shipper Shaft Bushings.
- Saddle Block Bushings
- Dipper Handle and Saddle Block Slide Plates.
- Shipper Shaft Gear Case.
- Intermediate Gear Case.
- Intermediate Shaft Bearings.
- Dipper Padlock Sheave
- Dipper Door Hinge Pins, Padlock Pins, Bail and Handle Pins
- Wire Ropes

PART	HOW OFTEN TO LUBRICATE	TIME TO LUBRICATE
Point Sheaves	3 times per shift	1. Start of shift
Crowd Fittings	3 times per shift	2. Two hours after starting 3. At lunch time
Fittings in House	2 times per shift	1. Start of shift 2. Middle of shift
Circle Rollers	1 time per shift	1. Start of shift
Cat Assemblys	Mud and Water Conditions 3 times per shift	1. Start of shift 2. Two hours after starting 3. After lunch time
	Dry Pit Conditions 2 times per shift	1. Start of shift 2. After lunch time
	Deadheading Every 1,000 feet	1. Start before deadheading
Open and Partially Enclosed Gears Sliding Surfaces	Normal Operating Conditions 2 times per shift on loading	1. Start of shift 2. Lunch time
	Deadheading As often as dry spots appear, or approximately every 1,000 feet	
Hoist Cables	Every 24 operating hours, Never let hoist drum cable grooves run dry.	When convenient When dry
Boom Support Cables	Once a month	While machine is idle,
Enclosed Gear Cases	Check oil level once a shift	Start of shift
Hydraulic System	Check oil level once a shift	Start of shift
Air Compressor	Check oil level once a shift Clean air filters and change oil once a month	Before starting

Center Pintle thrust collar at lower end is lubricated by hand pump on truck frame at idler tumbler end. Operate pump plunger two or three times, twice a shift.

GASOLINE OR DIESEL OPERATED MACHINES:
Clean air filters, change oil and filters each 100 operating hours. Always drain while oil is hot.

Always wipe off grease fittings to avoid forcing dirt into bearings.

Shovel operator, pit or loading foremen will be held responsible for checking lubrication work done during their shift, also the keeping of monthly lubrication record chart on shovel up to date.

Pit or loading foremen and operator are to sign record chart at end of their respective shift.

It shall be the duty of day shift pit foremen to see that there is enough lubricating materials and equipment on shovel to carry over the afternoon and midnight shifts at all times

Inspections of mechanical and lubrication conditions of shovel will be made by maintenance supervision and lubrication engineer during all shifts.

Lube Engineer

GOOD LUBRICATION MEANS
- SAFETY
- LOWER OPERATING COSTS
- FEWER SHUT-DOWNS
- MORE PRODUCTION
- JOB SECURITY

LUBRICATION EFFICIENCY is promoted by definite scheduling and reporting, as with this form for small shovels.

working periods, thus reducing output.

The preceding are among the reasons why a number of mines have placed responsibility for lubrication on special crews and have provided them with lubricating trucks. A typical underground truck usually is operated by a crew of two men, who visit all units in the mine or a section of the mine once a day on the off shift. The truck usually is equipped with tanks for two types of lubricants, with a third tank for hydraulic oil, and may be provided with hoses for blowing fittings, motors and the like as necessary with air from the compressor used in dispensing the lubricants. Where the truck is track-mounted and offtrack equipment is employed, the offtrack equipment may be brought to the loading station

once a week, for example, for thorough inspection and lubrication, with lubrication by hand at other times. The truck crew also fills lubricant containers for hand lubrication.

As for results, one mine bought a truck to serve eight loaders and nine cutters, and in the first 18 mo of use had only three bearing failures. Lubricant consumption was reduced 65% in the same period. Another mine using a truck reports that a loader can be greased completely in 10 min.

Trucks for strip equipment also may include fuel-dispensing equipment. One such unit comprises a gas-powered compressor, lubricating pumps, four lubricating hoses on reels, and four fuel drums with the necessary hoses. Air pressure is used for dispensing fuel as well as lubricants, and the unit serves tractors, drills and other smaller mobile units.

3. Centralized Automatic Lubrication. Minimum manpower and positive lubrication at all times are among the reasons for the rise in use of centralized automatic lubricating systems in coal mining. These systems dispense either grease or oil—more usually grease—and among other advantages reduce the chances for contamination to almost nothing, since the lubricants usually are dispensed from the original containers or if not, with a minimum number of transfers. Applications of centralized automatic systems include:

1. Loaders, cutters, continuous miners and shuttle cars underground. In some instances, the systems are designed to give the bearings a shot whenever the machine hydraulic system goes through a cycle, thus requiring no manual attention whatever. Some, however, prefer to leave start of the lubricating cycle to the operator because with automatic initiation there is the possibility of overlubricating, with grease getting into, for example, motor windings.

2. All bearings in preparation plants, with the possible exception of motors. Automatic systems, in fact, have included dispensing of grease to underwater bearings on sludge conveyors.

3. Heavy-duty off-highway trucks, including wheel and steering bearings. For a description of how it is done at one operation, with substantial savings in truck time, lubricants and replacement parts, see *Coal Age*, August, 1955, p 60).

4. Large stripping shovels and draglines, and possibly other smaller units. One company divides between hand and automatic lubrication of stripping equipment on the bases of (a) cost of special lubricating equipment v. the type of machine and its expected life, and (b) the fact that in many instances the man still would be necessary. Other major factors in this company's program (*Coal Age*, January, 1952, p 76) include lubricant standardization, detailed scheduling of lubricant application, reports on lubricant application, and prevention of contamination.

Results reflect (1) a reduction in the cost of lubricating materials—from 3.05c per ton in 1944 to 2.20c in 1950, in spite of increases in material cost, (2) a reduction in maintenance expense, and (3) a reduction in the losses in production time. The program includes both pit and preparation equipment, and at that time the reduction in cost of maintaining stripping equipment was estimated at $75,000 a year, and of maintaining a dry preparation plant (centralized lubrication), $20,000 a year.

SEALS AND FITTINGS

Effective lubrication, in addition to all the other factors involved, depends upon (1) the lubricant getting into the bearing, and (2) the lubricant staying in the bearing. Therefore, fittings, oilers, grease cups and the like must be of the proper type and must be in condition to function as needed. Otherwise, no lubricant. A No. 1 job of any men handling lubrication therefore is to check to make sure the fittings and lubricators are in operating condition, and to report promptly if they are not.

Bearing seals are unglamorous but nevertheless are vital to make sure that the lubricant is retained so that it is available for the job it is called upon to perform. The best in seals therefore is a necessity, and they should be checked thoroughly and frequently, and replaced when necessary. Among other things, this reduces loss of lubricant.

SCHEDULING

A efficient lubrication program depends upon definite scheduling of the work, accompanied by definite instruction as to the type of lubricant to be used. This means a written document for the information and guidance of all who have anything to do with lubrication, and this document may also serve as a report on work done. Tags enclosed in plastic envelopes may, for example, be tied to tractors, with one side of the tag showing points to be lubricated, type of lubricant to be used, and when lubrication is to be done, and the other side serving as a record of lubrication performed. Similar, more comprehensive schedules may be posted in strip shovels and preparation plants, or supplied to foremen and mechanics underground. In any event, the goal is to have something definite and thus avoid hit-or-miss application, buckpassing and the like.

REPORTS AND RECORDS

Unless somebody checks, adhering to an efficient system in lubrication, as in all other activities around the mines, is practically impossible. This means reports and records which, even though they involve paper work, provide the basis for intelligent operation and control.

Reports may be rather simple in nature, merely recording that a certain machine was lubricated on a certain date. An important item in any report, however, is whether certain bearings refused to take lubrication or took too much, since this is a signal that trouble is probably in the making. A rise in quantity used on each machine or in each application is a further signal that machine condition is deteriorating, or that certain parts need attention. And if experience has shown that adequate lubrication can be secured with certain quantities of materials, figures on quantities used also will reveal waste and loss through contamination or otherwise.

Quite frequently, as noted in the previous section, the lubrication schedule and the report can be combined into one document. An example illustrated is a combined schedule and report for a small stripping shovel lubricated by hand.

LUBRICANT SELECTION

The recommendations of the equipment manufacturer are the starting point in lubricant selection, with the second major source of data the service departments of the oil companies. A third source of information, provided proper records are kept, are the lubricating and delay reports, which may indicate that a change in type is necessary. When all the preliminaries are completed, lubricants then should be bought on specification rather than on general representations, and the rule should be the highest possible quality in view of the penalties now suffered as a result of equipment breakdowns. The latter, for example, comes into consideration when gear oils, for example, are being specified. Use of the extreme-pressure type covers all applications with a quality product and eliminates the chance of misapplication in lubricating the operating units.

Standardization—Too many types of oils or greases lead to confusion, misapplication, contamination and loss.

Careful study of the lubricating problem will show, in many instances, that a lesser number of types of high quality will do the job, since the variety of lubricants available includes many with the necessary spread in characteristics fitting them to several applications.

As an example of what standardization can accomplish, one large stripping organization, also operating a large and modern preparation plant, cut the number of lubricants from 29 to 9, as follows:

	Types Before	After
Motor oil, heavy-duty detergent	2	1
Gear oil, all enclosed gear cases	4	1
Antifriction-bearing grease	5	1
Plain-bearing grease		1
Open gears	3	2
Cable dressing	5	1
Compressor oil	3	1
Hydraulic oil	7	1
Totals	29	9

On-the-Job Supplies

PURPOSE: Keeping delays to a minimum by having the necessary parts in or close to the working section or pit face.

If a part is not close at hand, what might be only a minor breakdown can turn into a major stoppage if the item, such as a chain link or hydraulic hose, is missing, requiring a special trip to the supply house or the main shop. Limiting down time therefore requires keeping an adequate stock of the smaller, frequently used items in the section or pit, where they are readily available for the mechanic or electrician. Where heavier, less frequently used parts or critical assemblies are involved, one or more can be kept at a central location, perhaps on a truck or carrier, but still handier to the working sections or pit than in the main supply house or shop.

To prevent loss or damage, section parts should be kept in a supply cabinet, a parts box, or in lockers, drawers, etc., in the foreman's or repairman's shanty or office. Some mines also have found it advisable to keep certain special tools with the parts so that they are handy when needed. Lamps or other heating facilities should be provided for parts subject to damage by moisture.

Mobile Repair Units

PURPOSE: Reduction of breakdown loss by getting men, tools and materials to the scene quickly; also more effective use of time and wages.

The repairman's jeep, with space for carrying parts and supplies and lockers or compartments for tools, has become a fixture at many underground mines because of the speed with which it can deliver both men and materials to the scene of a breakdown. Similar units also speed up the work of wiremen, bratticemen and other service workers. Other mobile maintenance units include welding trucks—gas and electric—where there is an opportunity to use such equipment in fresh air. For bringing units to fresh-air locations, and for other purposes, including moves, crawler-mounted pullers or carriers have been found very useful at a number of mines, especially in low coal. And where machines must be moved long distances, such as loaders, miners and shuttle cars to main shops, lowbed transporters speed up the operation and save wear and tear on the units.

Where pullers are not available, several tricks may be employed to move disabled machines—for example, a drill motor with an adapter to power the crawlers on a loader for short moves.

Mobile maintenance equipment at one strip operation includes the following, aside from greasing and fuel trucks:

Small-tool truck for all types of small hand tools and parts normally required on maintenance jobs.

Large-tool trailer for transporting heavy tools required in major jobs on big stripping units.

Flat trailers for moving wood blocks, cribbing and the like.

Special heavy-duty trailer for hauling buckets and shovels up to 100 tons.

Small-parts truck.

Truck-mounted crane with boom sufficiently long to handle all lifting jobs necessary in maintaining 40- to 50-yard shovels.

Welding trucks.

The number and variety of units reflects the fact that this is a very large operation. At a smaller strip plant, this number and variety would not be practical, but a welding truck plus a general repair truck, or one truck for both purposes, represents possibly the minimum of mobile units.

COMMUNICATION

If for no other reason, a good communication system from the face or pit to the main office and repair shop normally will pay for itself through reduction in breakdown losses alone. In strip pits, two-way radio is one of the answers, and includes certain mobile units such as in the superintendent's car, the repair foreman's car or truck, and the cabs of the key stripping units. A good telephone or trolleyphone system yields the same results in deep mines.

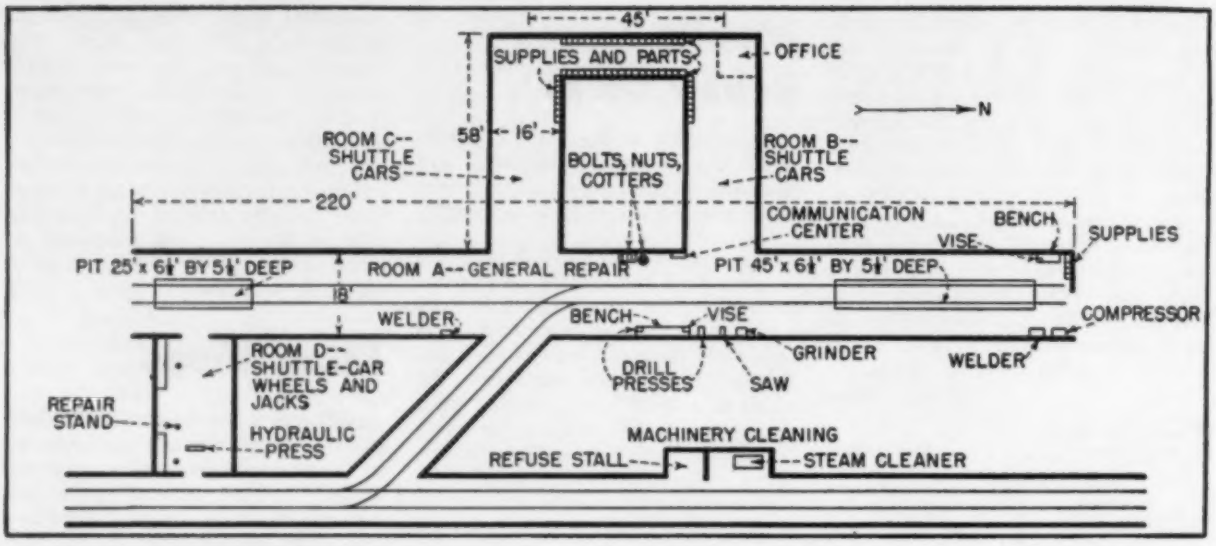
Mine Shops

Although a few deep mines make a practice of maintaining machines up to the stage of semi-overhaul in the working section, lack of space, the difficulty of doing welding, light and coal dust, among other things, normally dictate the transfer of major repairs, replacement of assemblies and semi-overhaul to shops maintained for that purpose. Some of these conditions do not prevail in strip pits, and consequently there is a greater opportunity for doing second-echelon work away from the shop. And with large stripping units, the only practical way to work on them is in the field in special repair areas, though some components and assemblies are processed in the shop or shops. In preparation, also, the nature of the plant and equipment also dictates doing a major part of the work on the job, though parts and assemblies may be removed for shop repair and return.

SHOP LOCATION

Deep Mines—Distance and whether or not the equipment must be hoisted up slopes or shafts are among the factors involved in location of deep-mine shops. A third is facilities for quick moving of units from the face to the shop and back, such as, special transporters. Where good transportation facilities exist, and hoisting is not involved, it may be possible to locate mine shops on the surface and thereby get the advantage of space, natural light and the like, including convenience, at a somewhat smaller expenditure. But where the distance is great, and where hoisting is involved, there are strong reasons for locating the shops underground. With proper planning and design, they can be made almost as convenient as surface shops—and as efficient—and have the major advantage of being closer to the actual working sections.

Moving the shop as the mining location shifts also is possible with certain types of mining—contour in particular, as well as auger. Some such operations use small prefabricated buildings



MODERN MINE SHOP includes machinery-cleaning section and special rooms for certain equipment and parts.

mounted on skids or trucks as shops or supply houses or both, moving the unit or units as needed as the mine opening moves around the outcrop.

Certain types of maintenance work, such as cable repair, may be done in small specialty shops set up at substations or other points where attendants are necessary to take advantage of what otherwise would be idle time.

Strip Mines—Central location and convenient access from highways, both on the property and off, are among the considerations involved in locating strip-mine shops. Frequently, these considerations result in the shop being located with the other mine facilities, such as, the mine office and the preparation plant, especially since big units are necessarily repaired in the field and trucks, tractors and small units can be brought in under their own power or by the use of transporters, even when they are not required to come to the preparation plant regularly. An exception might be a truck garage and shop where the trucks haul to field stations or to rough cleaning plants moving coal to central plants by rail after rough cleaning.

Specialty shops employed by some stripping organizations include a portable welding shop, fabricated from corrugated steel, and mounted on wheels, and large enough to go over a truck or other unit. This facilitates body and other repairs where the unit cannot readily be brought into the shop without dismantling.

SHOP FACILITIES

Even the simplest deep-mine shop for major repairs, replacement of assemblies and the like should be equipped with a pit, hoisting facilities and a parts store room, plus the necessary special tools required for the work done. Parts-cleaning equipment should be installed if possible to speed up this operation and facilitate subsequent work.

At the other end of the scale, mine shops may be large and elaborate and able to handle everything up to complete dismantling and reassembly of all types of machines. The plan for one shop of this type is shown in the accompanying illustration. Located near the bottom of the hoisting shaft, the shop includes high-intensity lighting, a general repair section with two pits plus overhead cranes and small hoists, two bays for shuttle-car service with hoisting facilities, an office, cabinets for parts, a room for repair and servicing of shuttle-car wheels and hydraulic-jack units with monorail crane, and a cleaning recess with permissible-type steam cleaner supplemented by a refuse stall. Tools include saw, floor-type drill press, vises, bench drills, floor grinders, hydraulic press, welding machines, and portable electric and air grinders. Facilities also include 32 tool cabinets built into the walls, and a compressor.

A similar range in scope of work and facilities installed prevails at strip-mining operations, although with these the tendency is to make the mine shop into the main shop.

IN-PLANT FACILITIES

Though not a part of shops, certain permanent facilities of a shop type serve very useful purposes in certain maintenance applications. Examples are compressed air and welding gas lines and outlets in preparation plants, and arc welders in preparation plants and strip shovels. Time saving is the major advantage.

Overhaul Scheduling

Five of the standards for determining when overhauling is necessary are:

1. Elapsed time—in weeks or months. In other words, machines are taken out of service at specific intervals for overhaul.
2. Operating time—in hours or days.
3. Tonnage or yardage handled.
4. Inspection.
5. Personal judgment.

Each of these standards has its supporters among maintenance and operating men, though more of them seem to operate on the basis of a combination of inspection and hours operated or tonnage or yardage handled. Where the number of units is large, on the other hand, supporters of the elapsed-time standard point out that a rigid schedule is necessary to permit getting around to all the machines without jams resulting from two or three coming up for overhaul at one time.

A sixth system is, in effect, no overhaul—or overhaul only at long intervals. Under this system, known as unit replacement, overhaul is accomplished by replacing assemblies, such as rear conveyors on loaders, crawlers on shovels and the like, removing the replaced assemblies to the shop for overhaul and storage until another assembly on another machine comes up for replacement.

Certain other tests may be used to determine when major attention or

overhaul is required. Oil pressure on truck engines is an example, as is rising lubricant consumption on, for example, cutting machines. In any event, the goal is to take the machine out of service when condition or an increase in down time indicates that major breakdowns will become excessive.

Main Shops

Main shops generally are defined as establishments where work beyond the removal and replacement of parts and assemblies is done. It is difficult, however, to be precise as to what main shops are, since they vary widely in goals, scope of work handled, and equipment. Normally, however, their main business is major repair and overhaul, and to facilitate this they usually include machine tools and other equipment not found in mine shops. On the other hand, main shops can function as mine shops, and they may also, in some instances, include facilities for manufacturing repair parts and even complete equipment units, such as, for example, pumps and shaker pans.

CENTRAL UNITS

Where several mines are operated by a single company, the question arises as to whether to have a main shop at each operation or a big central shop for all. The trend seems to be toward centralizing main-shop work in one plant, especially where good highway and rail connections are available. The advantages include:

1. Less duplication of equipment and facilities, in turn providing an opportunity for adding extra facilities in the main shop without increasing overall expenditure.

2. An opportunity to provide additional repair and maintenance skills because the volume of work is sufficient to warrant employment of certain specialists.

3. An opportunity for increasing efficiency because of the greater volume of work in one place.

4. Less duplication of parts and supply inventories, and consequently a reduction in inventory, as a result of concentration of operations.

SHOP TYPES

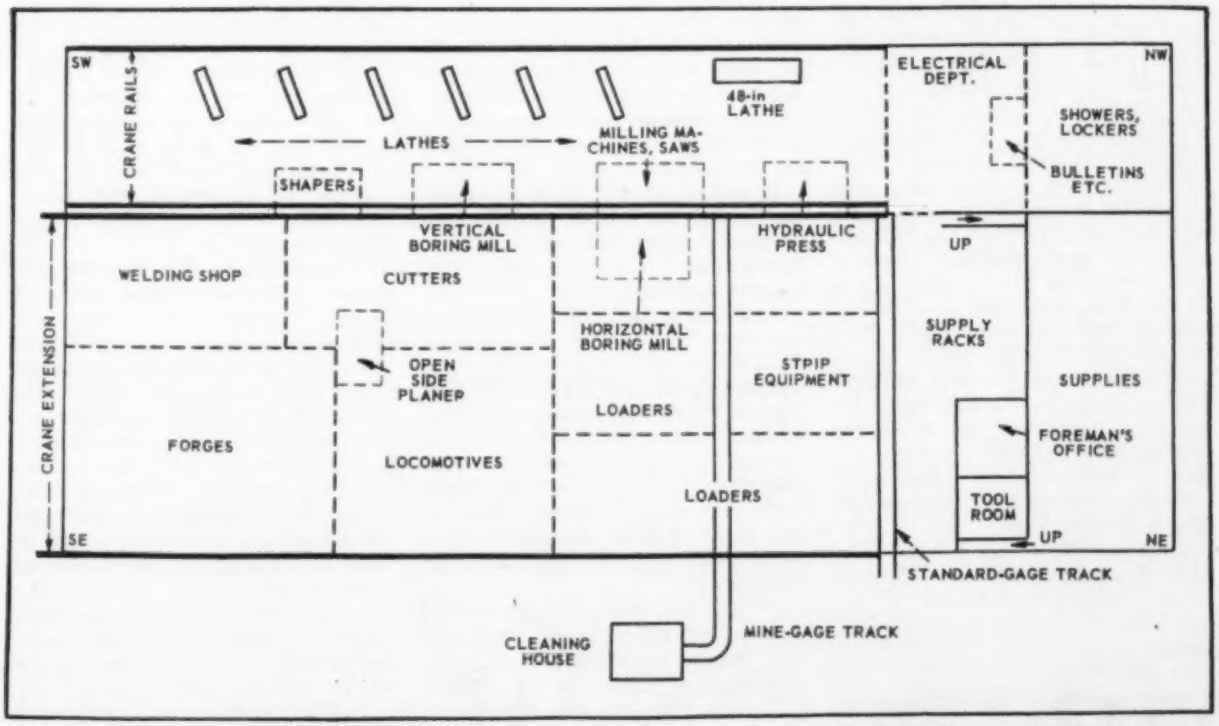
Main shops may include types aside from the general overhaul and repair units devoted to machine reconditioning. Examples are: conveyor-belt shops, cable shops, garage and truck-repair shops, wheel-reclamation and welding shops, truck-tire shops, mine-car shops and so on. Such shops may be separate or may be incorporated into the main shop via separate rooms, bays and the like, and, of course, are warranted only when the volume of specialized work is sufficient to make them practical.

SHOP LAYOUT

Since size of operation, type of equipment, type of work done and other factors vary widely, no prescription can be given for a typical main or central shop. A summary of layout and facilities for three specific shops, however, is as follows:

Strip-Mine Service Center—L-shaped shop, warehouse and garage structure, with 66x215-ft garage as the base of the L; next, a 59x32-ft warehouse; and, completing the upright of the L, a 59x84-ft machine shop. Thus, the warehouse is conveniently located between the machine shop and the garage. The garage is fitted with 10 rollup doors, and handles the maintenance and repair of all gasoline, butane and diesel equipment and pumps (but not motors), as well as serving as the headquarters for the maintenance of two small walking draglines. Extra engines, and some heavy spare parts, including some rear ends and transmissions, are kept in a fenced-off enclosure in the garage, which is equipped with a 2-ton hoist on an overhead track.

The warehouse includes a 25x25-ft partitioned section in one corner serving as the electrical shop. Warehouse facilities include convenient outdoor storage for heavy shovel parts while lighter parts that can be brought inside—via a 5-ton chain hoist mounted on overhead rails—are stored on the



MAIN-SHOP LAYOUT provides separate bays for certain equipment, and separate sections for reconditioning parts.

floor. Bins, of course, are provided for the smaller items.

The machine shop does work for the garage, electrical shop and the field force, and is equipped with three radial drills—one large and two small; horizontal lathe, 20-ft bed, 36-in swing; 12-in lathe, 18-in utility saw, shaper, bolt machine (up to ¾ in), three hand-welding machines, automatically controlled gas-cutting unit, automatic continuous welding machine, two 5-ton and two 2-ton chain hoists. Work done includes building dipper sticks 63 ft long or more.

Equipment serviced includes a stripping shovel, loading shovel, two small draglines, 13 semitrailers, 14 tractors, two winch trucks, two bulldozers and two road patrols.

Deep-Mine Central Shop—Three-building establishment, all connected with doors wide enough and high enough to permit passage of portable cranes, thus avoiding the use of heavy overhead cranes and hoists; windowless Quonset construction, with fluorescent lighting. Unit functions and equipment are:

Building 1, 40x100 ft, rebuilding shuttle cars, loaders and continuous miners; steel work benches, two bench drills, vises, two 300-amp portable welders, gas-welding equipment, air-operated impact wrenches and portable drills, test panel for mercury tubes.

Building 2, 40x100 ft, rebuilding rubber-tired cutters, rubber-tired coal drills, roof drills and other mining machinery; wall-type work benches, special floor-type work bench for repairing shuttle-car wheel units, two welding machines, cable vulcanizer, cable-conductor welder, and 150-kw rotary converter for DC test power.

Building 3, double Quonset 60x80 ft plus single Quonset 60x40 ft, building up and machining parts for mines and preparation plants; wheel press; 20-in, 48-in and two 24-in lathes, milling machine, radial drill, 20-in shaper, bolt threader, slotter, metal-cutting band saw, bit cutoff machine, blacksmith forge, air compressor for the three buildings, two degreasers, heating boiler, welding machine, and floor controlled bridge crane across lathe bay; also toilet and shower facilities in 20x20ft room.

Four portable cranes handle equipment in all three buildings. Two are 5-ton gasoline-powered units and two are 500- to 1,000-lb hydraulic push cranes.

Deep and Strip Shop—Though designed primarily for the complete rebuilding of underground equipment, this shop (floor plan in the accompanying illustration) also handles certain work for the company's strip operations. Size of the two-story building is 213x95 ft inside, and it includes offices and a supply room. Principal units of equipment and arrangement of facilities on the main floor are shown in the illustration. A modified assembly-line procedure is followed, with types of machines assigned to certain bays, and parts removed to service bays for reconditioning before return to the unit. An outside cleaning station is a major contribution to quality and efficiency.

While, as noted, shops vary widely in character and facilities, certain practices and equipment lead to higher quality of work at lower cost. These include: good light, convenient lockers and work benches, special benches and stands for certain work (shuttle-car wheels, for example), supply depots in the shops themselves or at least close at hand, hoisting equipment for lifting and moving anything heavy, including such things as shafts into lathes, and power-operated tools—impact wrenches, etc. Cleaning and degreasing equipment contributes greatly to comfort and efficiency in repair work.

Maintenance Materials

Hardsurfacing products are an example of materials that cut maintenance cost by increasing the life of machines and parts subject to wear, reducing the number of replacements and consequently saving not only in parts and materials but also in labor for replacement.

Examples of the other materials and parts that may be employed to lengthen machine and part life, reduce breakdown time and cut the cost of maintenance include:

1. Stainless and other alloy steel, aluminum and so on for strength, light weight and corrosion resistance in mine cars, truck bodies, stripping dippers, cages and skips, and so on. Light weight, provided there is the requisite strength, in itself reduces the maintenance load, or light weight with high strength permits building up parts without increasing total weight, thus reducing the chances of failures.

2. Stainless steel, manganese-steel and bronze for reducing wear and corrosion in coal screening.

3. Special alloys, bronze, rubber and other corrosion- and abrasion-resisting materials for pumps, valves, fitting and other equipment handling water and water with various solids.

4. Use of lime, by means of automatic feeding equipment, in wet-preparation plants where acid is a problem to reduce corrosion.

5. Cast iron, alloy, asbestos-cement, lined or plastic pipe for mine and other water lines to resist acid.

6. Rubber, tile, sprayed sand-cement and other corrosion- and abrasion-resisting materials for tanks and storage bins. Some companies have made complete bins of steel-supported glazed tile to resist abrasion and corrosion.

7. Glass, stainless steel and other wear-resisting materials for chutes, conveyor bottoms and similar applications.

8. Aluminum, protected-metal and other weather-resistant siding and roofing for preparation plants and other structures.

9. Protective coatings and paint.

10. Silicone, asbestos and other long-lived heat-resistant insulation for electrical equipment.

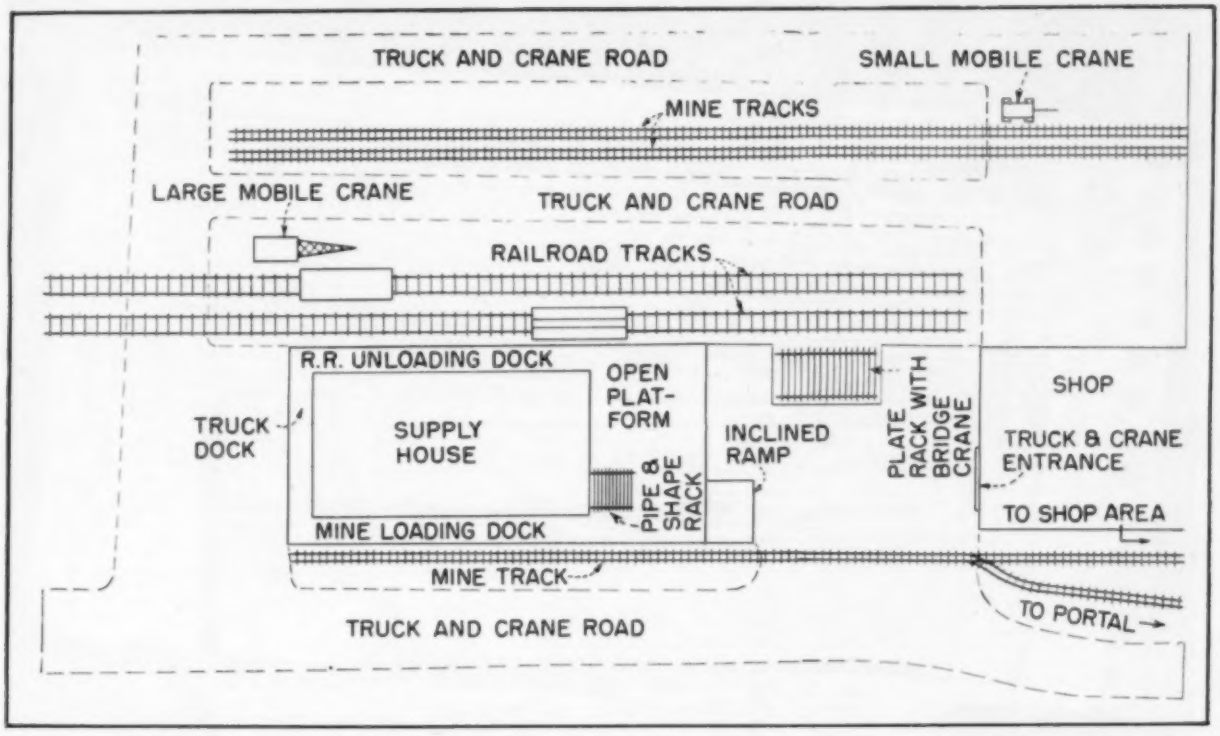
Mining Opportunities

In its broadest sense, maintenance goes beyond the care of operating machines and equipment and takes in many other installations around the mining plant. In other words anything that can fail or slow things down can hold up production, and therefore should be checked and cared for regularly. And if it fails or must be replaced quicker than it should if properly handled, extra expense is involved not only in the new material that must be provided, but in the labor to take out the old, clean up and put the new in place. In this broader sense, therefore, some of the steps that may be taken are:

1. Maintenance of a good haulage system, including regular attention to track condition, since poor track slows down haulage speed and results in wrecks, hampering production and also running up expense for cleaning up and repairing track and equipment. Even aside from these considerations, materials used in track construction can have a material effect on operating and maintenance cost. A treated tie, for example, can last 10 yr or more, against 2 or 3 yr for the average untreated tie.

2. Prevention of roof falls, which also stop production and require cleaning up even if no men are hurt or equipment is damaged.

3. Good weatherproof roads with minimum grades and good running surfaces for truck haulage at strip pits.



CONVENIENCE, EASY ACCESS AND PROTECTION feature yard designed for truck and mobile-crane operation. Accompanying supply house has receiving and loading docks on three sides.

The Supply Guidebook

COAL MINES spend an average of approximately 85c per ton for operating supplies and materials including repair parts. The low, usually at the smaller operations, is as little as 40c per ton or less and the high is over $1. Surveys by *Coal Age* indicate that the more-efficient operations tend to have supply costs at or above the average, reflecting the fact that keeping machines and men working requires an adequate flow of parts and materials. In other words, a good supply setup promotes efficiency and low cost in four major ways:

1. It enables machines and men to produce more by preventing interruptions resulting from lack of parts and materials—or delays in delivering them to the point of need.

2. It keeps investment in parts and materials to a minimum.

3. It prevents waste and loss of parts and materials.

4. It insures that parts and materials are received, stored and delivered to the point of use at minimum cost.

What is involved in a good supply setup and how to get it are the subjects of the material which follows in this Supply Guidebook.

Inventory Control

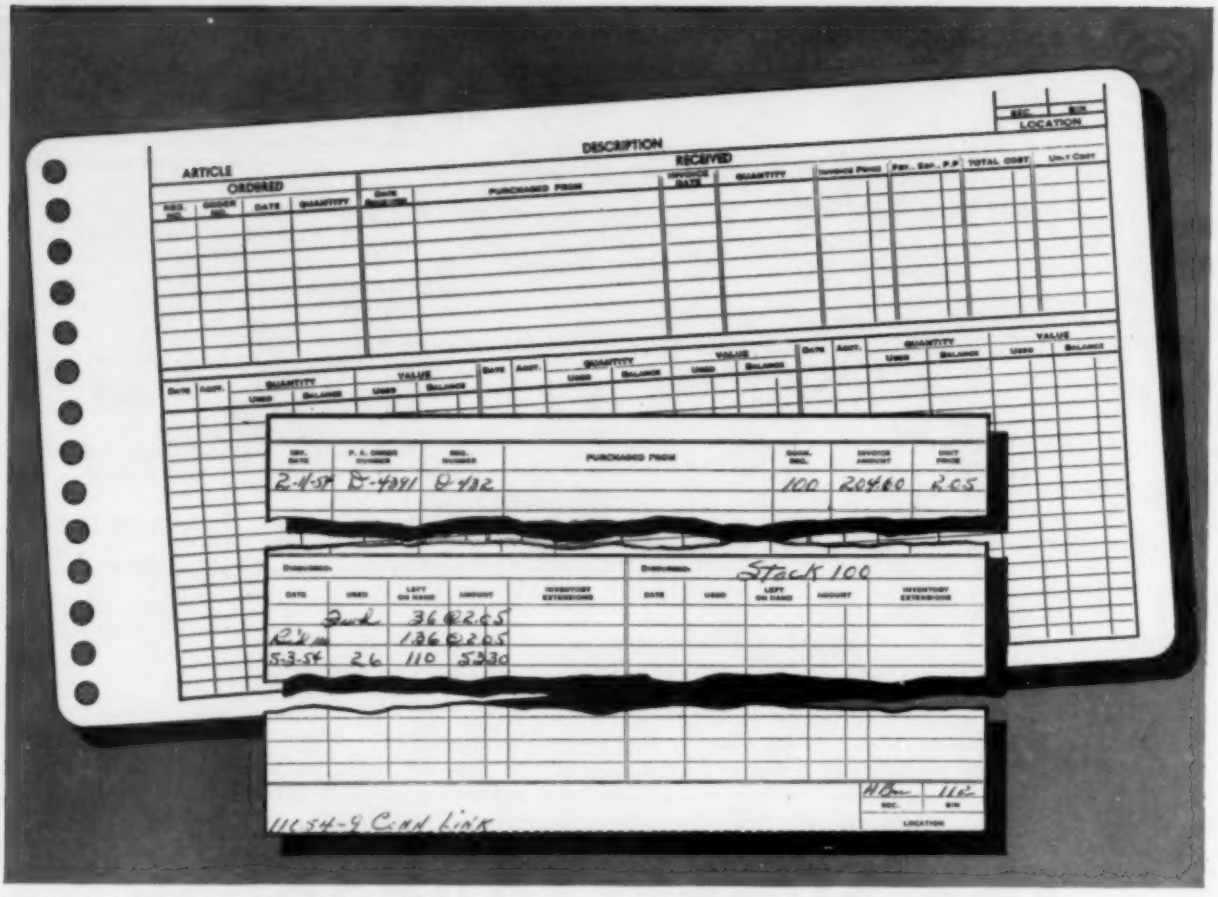
PURPOSE: Keeping investment in parts and materials on hand to the minimum consonant with efficient mine operation.

Too high a supply inventory means letting money lie idle, while too low an inventory can mean production delays and higher production costs. Depending upon mine location and other factors discussed in the following, the level of supplies at individual mines ranges from as little as $25 to $30 per ton of daily capacity up to $150 or more per ton at mines remote from manufacturing and distributing centers. The average appears to be in the neighborhood of $50 to $60 on hand per ton of daily capacity.

Under coal-mining conditions, the inventory level involves a fair amount of personal judgment based on experience and an analysis of parts and supply use in relation to time for normal replenishment. Some of the factors involved in arriving at a solution include:

1. Cost of item or a class of items in relation to production cost increases incurred if the item is not on hand when needed—for example, spare armatures or motors. For instance, how much, at the most, would a rotor failure on the main shaker-screen motor involve in payments for nonproductive labor, for power for ventilation and pumping during the production interruption, and so on? And would the cost be reduced if a complete motor was on hand instead of only the rotor? Or should the possibility of a stator failure be the controlling one and thus dictate keeping a complete motor ready for replacement?

In all these, it is assumed that the



PERPETUAL-INVENTORY SYSTEM provides a running record of supply receipts, disbursements and costs. Cards shown here are for loose-leaf ledgers (above) and tray-type files.

FLAGS on the bottoms of these perpetual-inventory cards, kept in tray-type files, permit easy checking.

tonnage loss could be made up at a later date and that the extra cost on the breakdown day is the major factor, though if the breakdown occurred near the end of the shift the loss might be reduced by better preparation in the mine for the following shift and consequently a higher tonnage and higher efficiency on that shift.

From the preceding, it can be concluded that there is no easy sure-fire formula for relating parts inventory to breakdown losses, though there is, of course, at least an approximate relation. Careful study of the problem is the best guide to informed judgment of what is needed.

2. Rate of use in relation to time required to reorder and get delivery of replacements. Experience normally will indicate the rate at which, say, controller fingers of a certain type are used. If new supplies could be secured in a month, then the maximum on hand at any one time theoretically would be a month. However, it may be considered desirable to have an additional reserve, which becomes largely a matter of judgment. Or, the

total use in, say, 6 mo, might be so small that it would pay to keep that much stock on hand to avoid the extra clerical and other effort involved in ordering more frequently. Also discounts for volume may be a factor in quantity ordered and consequently the total on hand at any one time.

3. Central warehousing v. warehouses at individual mines. Where one company operates several mines, it normally is considered more economical to operate one central warehouse provided certain conditions exist. These include:

A. Reasonable distances from central warehouse to mines to keep down delivery time.

B. Good highways and good trucking facilities to permit fast deliveries.

Where these conditions exist, central warehousing, as noted, is considered feasible and economical, except for certain types of supplies, such as, timber, rail and the like. Of course, a certain volume of other parts and supplies must be kept at each mine and, in fact, at each deep-mine or pit face, to facilitate maintenance and prevent operating delays arising out of such things as lack of timber, etc.

A major advantage of the central system is reduction in total inventory because it is not necessary to duplicate each item at each mine, particularly the larger, more-costly units, since, with fast delivery, a smaller number of, say, armatures can serve the several mines. Otherwise, it might be considered necessary to keep one at each property.

Exceptions, of course, include, as noted, timber, ties, roof bolts and other items used regularly and at relatively fixed rates which, once the rate of procurement and method are fixed, should be delivered directly to the mines to save rehandling.

4. Cooperative stocking. Where a part or a component is large, costly and requires considerable time to repair or, if completely wrecked, must be manufactured from scratch, it is possible for a group of companies in an area to buy one such component or part and rotate it around as needed. Thus, several companies—for example, a group of strippers using identical machines—are protected against major production losses with a minimum outlay for spare parts of a key and costly nature.

5. Independent warehousing. Where manufacturers, their agents and independent supply houses have branch or main establishments close to the coal fields, maintain stocks of the desired items and provide quick delivery, it is possible to use them as the source for many items, thus cutting down on both inventory and on company-owned warehousing facilities.

6. Price trends. If one is willing to risk the hazards of estimating future trends, it may turn out to be desirable to run up the inventory of parts and supplies—at least in part—to offset expected price increases, or to curtail purchases in anticipation of decreases. A more-rare occasion for perhaps increasing inventory is anticipation of decreased availability as a result of strikes, government control of critical materials, and so on.

Control Systems

PURPOSE: Accurate records of quantities on hand, quantities issued and dates of reorder.

While the plural "systems" is used in the title to this section, coal mines have largely settled on the "perpetual" system of inventory control. Basically, this system shows quantity and cost of units and materials received, quantity and cost of units and materials issued, and quantity remaining on hand at all times. From this, it gets its name "perpetual."

Two of the methods of keeping a perpetual inventory are:

1. Cards on each bin, particularly of the smaller items, on which the records of receipt, disbursement and quantity on hand are kept.

2. Cards designed for keeping in tray-type files, so-called rotary files, or in loose-leaf ledgers.

Wide use of the file-card system indicates that it is the handiest and surest. With bin cards or other systems, it normally is necessary to make an inspection or separate notes as the parts and materials are issued to determine if reordering is necessary, and those who have used the bin-card system report that there is a greater possibility of running short through failure to note that the time for reordering has come.

Inventory cards may be made up specifically by a mining company to meet its own needs, or cards, files and systems may be purchased from specialists in business machines and business records, who can, if desired, provide forms and equipment for even punch-card tabulating and record-making where the number and volume of supply items is large.

The accompanying illustrations show two types of cards provided by business-record specialists. One is designed for ledger use and the other for tray-type files. Both show purchases, including, in one type, cost of shipping, and both show cost and quantity received, cost and quantity issued and cost and quantity left on hand after each disbursement. The ledger form also includes a column for the account number to which the supplies are charged. Both also indicate warehouse section and bin number where the item can be found.

The perpetual system provides a running record of activity in supplies, and also an easy means of making periodic summaries of use. In some instances, certain types of supplies, such as, timber when bought locally as offered, may be excluded from the perpetual system. However, when there are exclusions, it becomes the responsibility of some supervisor or employee to make sure that (a) the items are not overbought, (b) that the quantity is not permitted to drop below the danger point, and (c) that data is supplied for the periodic supply-use and inventory reports. Most mines prefer to have everything in the system.

The records used in the perpetual systems also provide a convenient means of determining when reordering must be done. In other words, when the quantity left on hand after the last disbursement reaches a minimum shown by experience, a new order is placed. By the same token, the records may be used to prevent overbuying by establishing a top limit on quantity on hand, and also for maintaining an approximate average level between the minimum and maximum.

Certain types of cards are designed to permit the use of "flags," or colored tabs, to facilitate reordering and the compilation of periodic reports on use of parts, supplies and materials. A green plastic tab on the bottom of the card may be slid to the center the first time an item is issued in a monthly or other report period, and a red tab on the opposite side also may be slid to the center as an indication that the item is to be reordered when the next weekly requisitions on the purchasing department are prepared. The flags make it unnecessary to check each card for either preparation of the distribution report, or for reordering, thus saving considerable time and making it easier for the supply clerk.

Whatever the control system employed, it should be supplemented by an actual physical inventory. The practice varies between 6 mo and a year at most mines.

Even at small operations, an accurate record of receipts, cost and use is essential for wise and economical use of supplies, and while the perpetual or other good inventory system re-

ACCOUNT NO. LOADERS – 1–101

SHEET NO. _____

REPORT OF MATERIALS AND SUPPLIES USED AT _____ MINE FOR MONTH OF _____ 19____

DESCRIPTION OF MATERIAL AND SUPPLIES USED	QUANTITY USED	UNIT PRICE	SUB–ACCOUNT NUMBERS								
			LOADER #1	LOADER #2	LOADER #3	LOADER #4	LOADER #5	LOADER #6			
TOTAL											

MONTHLY USE REPORTS such as this lend themselves to summaries by account or function numbers, or by individual units. Here it provides a means of keeping track of parts costs by individual loading machines.

quires some paper work and the assumption of responsibility by some person, it can save both money and production time in the same proportion as in the larger operations.

Use Records

PURPOSE: Accurate determination of the cost of parts and supplies by functions or, in more detail, by machine and section, as a means of checking on loss, waste and destruction through carelessness, machine abuse, and so on.

Though it requires extra paper work, there is a growing tendency to go beyond the standard "supply-distribution report" and require more detailed reports on use of parts and materials by machine and by working section for the purposes listed in the preceding paragraph. The standard distribution report, usually prepared monthly, shows supplies charged to classes of equipment, such as, shuttle cars, and to mining functions, such as ventilation, timbering and the like. For convenience, each equipment class or mining function is provided with an account number.

Where account numbers are used, some hold that the daily or other delay reports (see the Maintenance Guidebook in this issue) provide—at least by inference—sufficient information to determine whether supplies are being used properly and economically. Those who are adopting the more-detailed system argue that definite and positive information is a necessity to prevent waste and loss through abuse and carelessness, particularly in view of the rising cost of everything that enters into mining.

Whatever the system, order forms, reports and records are essential for the proper evaluation of supply use. To start off with, nothing should be issued without an order, properly signed, stating what is wanted and where it is to be used. This applies even if the item is for current use, such as, timber, or is to go into, say, a section parts depot to replace some item used in maintenance. And for a check and appropriate action, summaries of supply use should be prepared at regular intervals for the information and use of mine and operating management.

The monthly distribution report previously referred to and prepared by account number is one form of report to mine and operating management. Where more detailed data are desired, the form or forms may be expanded to show items charged out to each machine, to each working section and to each general function, such as pumping, thus providing a better opportunity for determining whether abuse is running up parts cost for a particular loading machine, as an example, or whether certain sections are taking a larger-than-normal supply of timbers, perhaps indicating waste.

Aside from reports derived from the regular requisitions, special reports may be required of certain officials and mine employees. For example, a single carbide-tipped cutter bit can cost $1.25 or more, and, therefore, some operators feel that it is in order to ask the section foreman or machineman to report daily on number on hand at the start of the shift, number received for replacement, number sent out for grinding, number destroyed in operation, and number on hand at the end of the shift. Similar records could be required for other small and relatively costly items, such as, roof bolts, steel ties and the like.

Since they are required to report on use, the men responsible naturally would take care to prevent loss, and if the record showed excessive destruction, for example, there would be an opportunity to check to find out why. Incidentally, such records also would reduce the number of small items, such as, cutter and drill bits, that would find their way into the railroad cars, particularly if the responsible men were required to turn in the worn-out or broken items.

To wrap up a detailed record system, it naturally should show transfer of certain materials, such as, steel ties from one working area to another, thus guarding against, among other things, possible loss through carelessness or buck-passing. And if such things as timber were salvaged for use elsewhere, the records should show

MOBILE CRANE with various attachments, including clamshell and the timber fork shown here, handles heavy materials in the supply yard and can unload a car of ties in less than 1½ hr.

how much came out of a particular section and where it went as a means of gaging, among other things, the effectiveness of a salvage program.

Naturally, records of this type are valuable only if the information derived is made available to the proper officials—hence the need for the distribution reports previously noted.

Allocation Of Stocks

PURPOSE: Preventing production interruptions by providing stocks of parts and materials at or near the point of use.

Even where only one mine is involved, the satellite principle of stock allocation is necessary to keep production interruptions to a minimum. In other words, stocks of frequently used machine parts, as an example, should be kept close to or in the pit or underground section for the use of the section or pit electrician or mechanic. Otherwise, major delays may occur as a result of having to send outside or to the main supply house for a needed item.

Type of unit and experience indicate the types of parts and materials to be kept in such satellite pit or face depots. Normally, replacements for such stocks are charged to operating cost when they leave the main supply house. If it is desired, as discussed previously, to keep accurate use records, the section or pit electrician or mechanic can file reports showing use of items by machine number, thus enabling operating management to keep track of where parts and materials go. Rather than a separate report, the section mechanic's or electrician's daily delay and repair report (see the Maintenance Guidebook) can show what items are used and where.

Where two or more mines are involved and the central warehousing system is employed, allocation might be along the following lines:

1. Principal stock of repair parts at the central warehouse.
2. Subsidiary stocks at the central repair shop, provided it is not adjacent to the central warehouse.
3. Subsidiary stocks at the mine shops.
4. Section stocks in the working sections or pits for running repairs and maintenance.
5. Stocks of ties, timbers, roof bolts and similar items at the individual mines, since it is more convenient and less costly to have such materials delivered directly to the mines for storage and distribution rather than rehandling them from a central point. In fact, even where only one mine is involved, it may be more convenient to provide separate facilities for receiving, storing and distributing (a) machine parts and smaller items, and (b) larger, bulkier items used every day the mine runs.

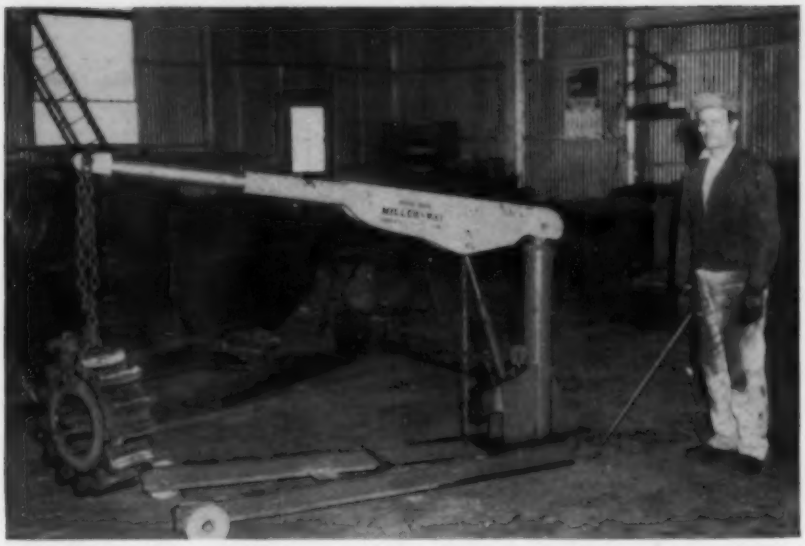
There are, of course, many modifications of the preceding systems to suit individual conditions. The goal in all should be, however, providing adequate stock at points of need whatever the system employed.

Storage And Handling

PURPOSE: Protection as necessary, and receipt, storing and issuance with a minimum of labor.

Type, size and cost of specific items normally dictates methods for receipt, storage and issuance. Thus, depending upon these factors, both enclosed and open storage are employed at mines. Enclosed or covered storage includes both regular supply buildings and also sheds for certain items requiring less protection.

Open or yard storage is satisfactory for timber, steel ties, rail and the like, including heavy equipment items that are not appreciably affected by rust and other deterioration as a result of exposure to rain, snow, dust and the like. Where the items are made, for example, from copper and lend themselves to theft, enclosed storage normally is dictated to prevent losses of this type. Shed storage may be desirable for pipe, structural shapes, plate and the like to prevent excessive rusting and also avoid difficulties with snow and rain in storing and handling. However, shed storage rules out, in most instances, the use of mobile cranes in handling such items, and the



PUSH-TYPE LIFT TRUCK eases problem of handling heavy parts and units in supply house and shop. The units also may be motorized.

OIL-HOUSE OPERATION is facilitated by equipment for easy handling of drums, such as these castor-mounted tilting racks.

GRAVITY OPERATION in dispensing sand is facilitated by such measures as boreholes or, as here, bin over the drift portal.

ability to use such equipment may outweigh the disadvantages of open storage.

STORAGE LAYOUT

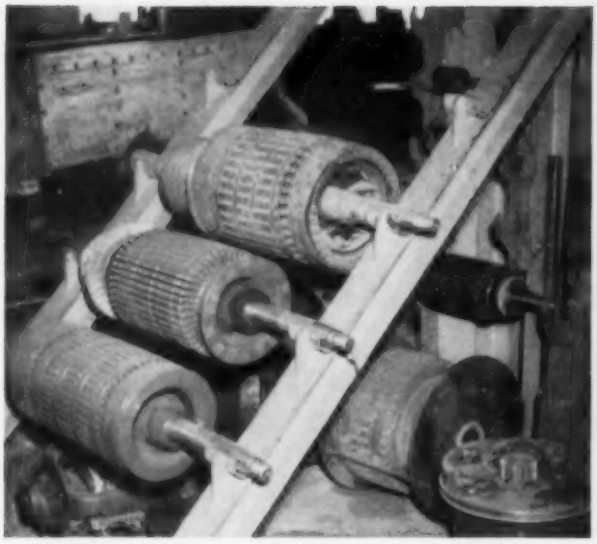
While the storage layout will vary from mine to mine, the plan shown at the start of this Supply Guidebook illustrates some of the basic principles involved in achieving efficiency, convenience and protection. In this instance, the shop is near the supply house and thus a separate shop supply is not required. The principles illustrated include:

1. Receiving and loading dock completely surrounding the warehouse. This is a practice that can be followed if desired, but it may not always be necessary to surround the supply house with docks, though provision should be made for sufficient dock space both for receiving and for loading to mine equipment. The docks in the setup illustrated are at the right height for receiving material from railroad cars or trucks, and for loading materials into mine equipment without excessive lifting or lowering.

The design permits running hand trucks or other mobile equipment directly into cars or trucks in most instances for unloading, and also permits lowering items directly into mine equipment. It will be noted that for the most part items are taken into the supply house from one side and then moved directly across to the mine track. If desired, the truck dock may be reduced to one-truck width, extended inside the supply house, and equipped with rollup doors so that loading and unloading can be done completely out of the weather. The railroad unloading and mine loading docks also may be roofed if desired, but here again a roof may prevent the use of mobile equipment for handling heavy items.

2. Open storage planned so that as heavy material is unloaded it can be placed so that it is convenient for loading into mine equipment. Roads are located so that mobile cranes can be used for unloading railroad cars or for lifting heavy items out of storage into mine equipment. These same roads permit unloading such items as mine props directly to the mine trucks if desired.

3. Use of power-operated handling equipment. The mobile crane, with various attachments, including clamshell for sand and gravel, and fork for props, rails and the like, or other mobile handling unit materially reduces labor and also the hazards involved in handling heavy parts and materials. With a fork-type grab, for example,



SPECIAL RACKS accommodate spare armatures and provide protection until put into service.

REELS for cable and similar materials facilitate storing, handling and measuring out pieces.

two men can unload a car of ties in less than 1½ hr. Aside from cranes, mobile handling units include motorized wheelbarrows, motorized high-lift bucket-type loaders and carriers, high-lift fork trucks, crane trucks and so on.

Overhead Elimination—Added flexibility is achieved in the yard illustrated by the complete elimination of trolley wires—a growing trend in the design and operation of supply yards. Elimination of wires also eliminates a hazard, which still is present even if continuous guards are installed. Without trolley wires, material can be stored and reclaimed from either side of the mine track, and high-lift mobile cranes can handle materials across one or even two tracks without difficulty. Cars are handled in such yards by battery locomotives or, more commonly, by locomotives powered by gasoline or diesel engines.

4. Open platform with inclined ramp provides open storage for certain parts and materials and also makes it easier to get equipment, such as, shuttle cars, loaders and the like out of railroad equipment and down to mine-track level. Handling of heavy items on the platform can be done with the mobile cranes, or the platform can be equipped with crane rails and a hoist. An alternative is a crane track extending out of the supply house to the platform both for handling materials on the platform, or for moving them inside to floor storage. The plan illustrated also shows an open plate storage with traveling crane and hoist. Plates are stored on edge between stanchions.

As noted, there are many variations in layout to suit individual mine conditions. Among them are incorporating the supply house into a larger structure serving, for example, a truck garage and repair depot on one side, and a machine shop and general repair shop on the other. Or the supply house may parallel the shop with a track in front of the doors to the shop for loading parts and materials into the mine equipment brought in, say by a diesel or battery locomotive. Thus, most of the loading equipment is under cover.

SUPPLY-HOUSE FACILITIES

Supply houses include both bin storage for small or moderate-sized items, and floor storage for heavier units. The floor-storage facilities at one new supply house include a basement for cool storage of rubber-covered cable, conveyor belts and other rubber items. Access to the basement is by 25-ton hydraulic lift, large enough to handle even the heaviest reels of cable and belt, which can be rolled on and off.

Some supply houses include a monorail and hoist for handling heavy units into and out of the floor-storage area, and storage facilities for such heavy items, include, in addition to open floor, racks for, say, spare armatures.

Other facilities which have proved successful in simplifying the handling of supplies in warehouses include: sectional steel bins with adjustable shelves; drawer-type and rotating bins for small items; clear plastic chest and drawer units for miniature units; shafts and reels mounted on walls or stanchions for convenience in paying out and measuring cable, hose, rope, etc., peg racks for V-belts and similar items; and platform-top push trucks for moving items to and from bins, especially if the warehouse occupies a rather large floor space.

If bins are built up higher than eyesight level or arm's reach, trolley or wheeled ladders or steps save time and reduce the possibility of injury. One wheeled step, for example, includes springs which give when a man puts his weight on the steps and thus provides solid footing.

Light should be ample to read tags, nameplates and the like, and the sources should be placed so that it is relatively easy to see into the backs of shelves or bins, especially those high up.

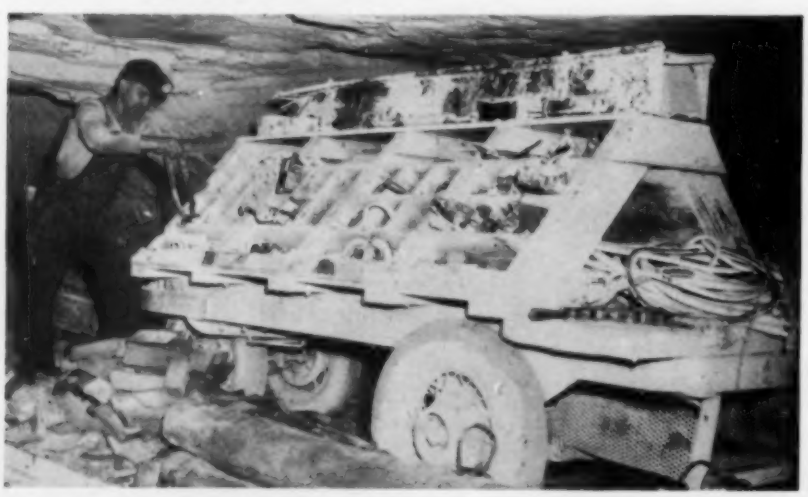
In addition to provisions for hand trucks, some companies have found it desirable to provide aisles wide enough—at least in the areas where heavy units are stored—to permit small push-type mobile cranes or even motorized units to be brought in for moving say, armatures to a neighboring shop or to cars or trucks for mine delivery. This presupposes floor construction strong enough to stand up under the traffic and also floors at ground or loading level, or ramps at convenient points, to permit mobile units to travel in and out from ground or other level.

Special Supply Houses

Supply facilities falling into what might be termed the special class are:

STORAGE-IN-TRANSIT FACILITIES include these rubber-tired explosives trucks at a stripping operation.

VERSATILE FLAT-BED TRUCKS facilitate supply delivery. Diesel locomotives are finding wider use in yards.



HANDY SECTION PARTS DEPOTS include this wheel-mounted unit designed for trackless sections.

powder and oil houses, sand-storage and drying establishments, and even portable or semi-portable pit or mine houses.

Design and location of powder houses is a matter of following the recommendations of state and federal safety authorities and the Institute of Makers of Explosives. Factors to be considered with other types include:

Oil Houses—There is good reason for putting oil houses and oil-storage facilities apart from other surface units. Oil and grease are, after all, flammable. However, there is no reason why they cannot be located for easy receipt of supplies either by truck or rail. As a matter of fact, convenient, clean and safe facilities for dispensing are as much factors in oil-house design as storage.

Designs most nearly meeting these objectives include: steel and concrete construction, racks that hold drums in proper position for dispensing, hoists or other mechanical facilities for handling drums, and provisions for catching drip and spillage. Fixed racks should be provided with inclined ramp rails to permit rolling drums up to position, unless chain hoists are used. Chain hoists, incidentally, make it easier to replace drums without handling of others, as do tilting-type racks with castors, which may be pulled out of position, run to the storage area and tilted to permit taking off the drum, after which the process is reversed to put a new drum into position.

Sand Houses — Terrain and other considerations affect sand-house design and location. If possible, the facilities should include storage for a specified number of truck loads. In hilly country, where sand is received by truck particularly, it may be possible to build the road up on the hillside so that trucks can dump directly to the bin.

The preceding comments presuppose gravity flow from the wet storage bin to the drying stove or stoves, and from the stoves or dry-sand bins to the locomotives, sand cars or borehole to the mine bottom. This gravity flow materially reduces labor in all phases of receiving, drying and dispensing sand, and this saving may warrant a substantial investment in bins and gravity-handling facilities which, in some instances, are almost or completely automatic.

Though not yet possible in too many mining areas, sand-handling facilities may be eliminated completely by depending upon outside suppliers for drying and delivery. At one operation, the custom drier delivers the

TRAILER PULLED BY BATTERY TRACTOR solves problem of supply delivery in trackless-mining sections.

sand in oil-type drums ready for movement into the mine.

Portable Supply Houses—Under certain circumstances, a "portable" supply house becomes quite convenient in addition to providing protection and promoting order in dispensing supplies—particularly machine parts. One circumstance is stripping where frequent moves are made from one location to another. Another is deep mining of the contour type, where the main opening keeps moving around the hill. Under such circumstances, a number of mining companies have bought small prefabricated buildings and mounted them on skids or trucks for towing from one location to another.

Supply Delivery

The motor truck in its regular form is the work horse in supply and delivery on the surface. In its special forms, especially at stripping operations, it includes grease trucks—usually designed for actual application of the grease at the point of use as well—fuel trucks and utility trucks. And at some operations, the final stage in storage and delivery of explosives—at strip mines, for example—is handled by small rubber-tired units designed for towing on the bank by tractor, relieving the regular truck for other duties.

For delivery between supply house and shop, for example, where the two are not too far apart and are connected by a hard-surfaced roadway, some deliveries may be handled by hand-pushed lift cranes, motorized cranes or special motorized flat-bed trucks.

SUPPLY TRANSFER UNDERGROUND is facilitated by hoist and monorail at one trackless operation.

UNDERGROUND DELIVERY

Where mine cars are employed to haul coal, the same track is used for delivery of supplies—perhaps to the face or, if trackless mining is the rule, to the point where the rails end. Even with belt haulage, convenience in handling supplies and men has led a number of operators to put supply tracks alongside the belt conveyor—or in a parallel heading. Battery locomotives may be employed for pulling the equipment on such auxiliary track systems to avoid having to put up trolley wire. And in some instances, rubber-tired tractors and trailers are employed to take in supplies, eliminating track completely. With either system, the added convenience and saving in time and labor is held to warrant the installation of the track or the preparation of the special roadway for the trackless battery units.

Where belts are installed for haulage, especially single panel units, they may be provided with reversing facilities for movement of supplies back to the face. In some instances, at least, special inching and jogging controls have been provided to facilitate handling long crossbars and other items without hazard to men or to the belt and conveyor.

Facilities for delivering supplies to the faces of rooms equipped with conveyors include:

1. Dolly trucks running in shaker lines.

2. False pan lines, or lines of pans alongside the operating line, which

are loaded with supplies and pulled up as the main line is extended, the face pan going into the operating line and the supplies to other face operations. At the same time, a new pan is added at the outby end and loaded with supplies until the place is halfway up, at which point the loaded line will complete the place.

In pitching places, small hoists may be included in the equipment at the face to pull timber and other materials up from the track on the gangway below.

Mobile Units—For the most part, unless pitch or some other condition prohibits, the mobile unit operating either on or off the track is the most efficient and flexible unit for supply delivery. In trackless areas, the mobile unit may be a shuttle car, though using a shuttle car on the working shift may result in interference with production. If supplies are delivered on the off-shift, the shuttle car may well double in brass. And if crawler trucks are used for moving shortwalls, these same trucks may also be employed for handling heavy units, such as motors, drives and the like. Special crawler-mounted puller sand carriers also have been built for moving drives and for handling materials.

The extra advantages of special equipment, including availability at all times, design for handling materials and the like, have led, among other things, to a substantial growth in such equipment as battery-powered tractor-trailer units, especially in trackless areas. Some mines also have used the equivalent of a straight truck with a battery for power.

For rail delivery, the mine car, as noted, still is the mainstay. However, special cars and trucks provide a number of advantages, including better design for loading, unloading and protection of materials and supplies. An example is the low-height flat-bed car with steel deck and holes all around for stakes, which lends itself to handling almost any shape or size of material or part. Such cars are used on moderate-pitch slopes as well as on the flat. In tandem and properly loaded, such cars also can move rails and long timbers, though the special rail truck still is a standard item at most operations.

Other special cars which a number of operations have found advantageous include the following:

1. A utility car with a cab for the snapper equipped with plastic windows, and compartments for such items as steel ties, miscellaneous track and trolley supplies, coal augers, roof bolts and the like.

2. Sand cars especially designed for the service, including sides low enough for easy unloading to sand boxes.

3. Enclosed powder cars with sliding doors and insulated couplers.

4. Special insulated detonator cars with steel doors, wood and rubber lining, and compartmented drawers.

5. Special ballast cars with bottom doors designed for spreading ballast in the track.

Special handling facilities at unloading or transfer stations underground can materially speed up the job and reduce the hazards. Oil drums, for example, may be lifted off trucks or out of cars by a small chain hoist and run back into the underground depot on a monorail. Similar facilities also may be installed for handling timber, roof bolts and other bulky, lengthy or heavy materials and parts. Handling is facilitated by bundling or tying the materials, such as, timbers, to make it easier to hook onto them with the hoist. In fact, some companies ask that lumber and certain other materials be bundled and strapped by the supplier to facilitate handling all along the line. Properly designed, underground stations of this type make it easy to unload and store materials until the face equipment is ready, then facilitate reloading for distribution.

Preventing Waste And Loss

There is no particularly easy road to reducing waste and loss in parts and materials, but results can be achieved by, among others, the following methods:

1. Good Records—Where supplies go and how much (see "Use Records").

2. Education—Some companies have found, for example, that a display of certain supply items, each tagged with its cost and accompanied by some pertinent words by the superintendent or foreman, brings home to men the costs involved in loss or carelessness and consequently leads employees to handle materials and parts more carefully.

3. Prevention of Machine Abuse—This is largely a matter of training both operators and supervisors in how abuse results in breakdowns, lost time and an increased cost for parts.

4. Rated Voltage—Along with education of operators and supervisors, the rule should be rated voltage at the terminals of all machines, since less than rated voltage inevitably results in an increase in machine breakdowns, with attendant loss of time and increase in parts consumption.

5. Protection—Moisture in cement, coal dust in an open container of oil, and a bundle of roof bolts thrown along the rib and covered with loose coal are all examples of loss through failure to protect materials and supplies. The moral is enclosed storage for materials or parts subject to weather or water damage, enclosed containers for lubricants all along the line from receipt to point of use, and specific places for everything in the supply line—for example, special supply delivery points, with cabinets, chests and the like as necessary in every section for receiving and storing parts and materials. Indiscriminate dumping inevitably results in loss.

SALVAGE

The extent of salvage operations depends upon the value of the part or item in relation to the cost of getting it out and, if necessary, reconditioning it. Expending $2 of labor to recover something worth only $1 in the first place is, of course, out of the question. However, in view of the cost of materials and supplies these days, a carefully considered salvage program can results in major savings.

Education is a major ingredient in an effective salvage operation. In other words, if men are encouraged to form the habit of picking up anything they see lying around and turning it in to a specific salvage station—on each section, for example—rather than walking by or, even worse, pitching things into the gob without thinking, the company benefits not only by the return of usable parts and materials but also from the scrap value of worn out items. Of course, each foreman should check on loose and misplaced materials constantly.

Certain items lend themselves to the use of organized salvage crews—for example, crossbar and post recovery. Equipped with mobile pulling units involving wire lines, chain slings and winches, such crews can, where safety considerations permit, recover several times their wages in posts and bars—as well as ties, rails and so on. A few mines have even used mine-detector-type equipment to find carbon-dioxide coal-breaking shells, steel ties and like buried in loose coal or gob in working places.

A new trend which shows signs of growing is the formation of special salvage organizations. As an example, one company appointed an experienced mine superintendent as head of salvage, provided him with facilities at a worked-out mine and gave him final authority as whether a piece of equipment or a part should be rebuilt or finally junked. It expects a substantial saving per ton over the hit-or-miss program previously in force.

SOLID ORGANIZATION, within the company or above the company level, provides a sound base for effective safety work. Providing qualified men for the safety-promotion job is one of the important functions of top management.

The Safety Guidebook

IMPROVED SAFETY can be predicted with confidence when good planning and zeal are applied to get it, just as in all other phases of mine management where benefits are expected as a matter of course in proportion to the skill and effort put forth. Assuming a sincere desire for improved safety exists at top levels and all down the line, the achievement of the goal then becomes a step-by-step process.

If safety promotion can be reduced to anything resembling flowsheet terms, the dominant lines of flow might go somewhat like this:

1. Organize for safety, employing all available skills to the fullest degree and enlisting all interested parties.

2. Train and educate for safety, using well-planned, interesting programs for workmen, supervisors and management.

3. Maintain the physical features of the mine and its surroundings in the approved manner to eliminate conditions leading to accidents.

4. Keep interest alive by running a continuous program of safety incentives, any of which may be scrapped without remorse the minute it loses its appeal.

Although safety is its own reward, these four guides will lead to other benefits, such as, higher morale, a stabilized labor force and higher efficiency, which lead in turn to lower costs.

Safety Organization

The type of organization depends upon the job to be done. Within the company there are a number of functions to be performed. Someone must head up the program, someone must inspect the workings, the ventilation system must be patrolled, training must be conducted, and so on. If the company is small all these responsibilities may be handled by one man. In larger companies, operating a number of deep and strip mines and cleaning plants, the safety department may include one or more qualified men to fulfill each of the functions.

The important requirement is that some provision be made for handling each function, and this is another top-management exercise in bringing together the skills available within the official family and the jobs to be done. The staff of the company safety department should be neither too large nor too small. An overweighted safety department may become a "dumping ground" for a number of other activities for which a natural home cannot be found in other company departments. The result is a loss of enthusiasm for safety work.

The understaffed safety department, on the other hand, may miss too many good bets in safety because of difficulty in maintaining proper coverage of its legitimate responsibilities. The best way to get the proper manpower, in quantity and quality, is through sincere top-management consideration of the matter. A top-notch safety department is worth the effort because it pays off in better employee and public relations, reduced labor turnover and increased efficiency.

Employee safety committees should be included in the table of organization. Their recommendations concerning hazards should be heeded and acted upon, their suggestions should be carefully weighed, and their active

ADVANCED TRAINING for selected men is a good way to develop potential instructors for basic training of other men.

support in training and promotion ventures should be solicited.

Above the company level a need may exist for an organization to promote safety for a group of mines or companies having similar safety problems. A full description of an organization of this type appears in the regular September, 1955, issue of *Coal Age*, beginning on p 58 and featuring the highly successful operations of the Indiana Joint Committee for Coal Mine Safety.

Wholehearted support of local safety associations and institutes by the company and participation of company safety officials in the affairs of Holmes councils and chapters, the National Mine Rescue Association and National Safety Council, for example, are proper extensions of top-management's interest in safety. These, too, represent organization for safety.

Training and Education

The terms training and education are not synonymous. They are two distinct functions, differing in scope and in emphasis. Safety education is a broad program designed to convince workmen and supervisors of the waste inherent in a high accident rate, and of the real values in high safety performance. Safety training, on the other hand, usually takes the form of

MAINTENANCE OF PROPERTY in safe condition calls for the use of modern equipment like this rockduster and spray system, in addition to procedures for inspecting, reporting and repairing to keep physical plant free of hazards.

FIRE PROTECTION, portable and fixed, is indispensable in highly-mechanized mines to prevent tremendous losses in property and perhaps lives. Some mines now have water systems which provide taps at intervals of, say, 500 ft.

SAFETY SUPPLIES should be provided at well-marked locations throughout the mine and the caches should be inspected periodically and replenished.

a hard-hitting direct attack on particular hazards, like 100% training in accident prevention. Safety education is a continuous process, while safety training, on any particular subject, begins, proceeds and concludes in a scheduled well-planned manner.

The educational mission can be carried out through the use of a company publication (if thoughtfully prepared), a well-planned poster campaign, word-of-mouth advice and management example. The safety-display board near the lamphouse or at the entrance to the property can be a big help here. If it can't be kept timely, however, and if it isn't kept reasonably clean and in good repair, it might better be removed from sight.

TRAINING FUNDAMENTALS

A need for training may be indicated by a general rise in frequency or severity rates. Or the number of injuries chargeable to a single cause—haulage, for example—may spurt upward. Next step is to select the training material, basing the selection upon the recognized needs of those to be trained. If an outside agency is to conduct the training, these instructors and company representatives should meet to examine the content to make certain it fills local needs.

Course material should be severely limited to the interests and needs of the trainees. In a course for cleaning-plant personnel, very little reference need be made to the fact that roof falls and haulage are the major causes of accidents in the industry. They are more concerned with safety on stairs and ladders, and with such other matters as falls of person, open machinery, dust hazards and electric shock.

The problem of getting men to attend the training sessions can be a tough one. The safety committee can be of great help here, if the committee has been consulted early in the planning stages. In striving for 100% attendance at accident-prevention training sessions, conducted by Bureau of Mines instructors, company officials will achieve maximum results by working closely with district officials of UMWA.

Striking examples of the safety benefits to be derived from well-planned training efforts are presented in *Coal Age*, July, 1953, p 100; December, 1953, p 66; and May, 1955, p 93.

Beyond this basic training area there is advanced training work any company may profitably pursue. Periodic training in advanced first aid and mine rescue may be offered to selected men and supervisors. One important goal of this training should be the development of new instructors.

Training, though, is not an end in itself. The clincher is in management's follow-through, making sure the training came off as desired.

Maintaining Physical Plant

Vigilance is the keyword in maintaining a mine, cleaning plant or strip pit in safe condition. A sluggish track switch in the mine, "soft" brakes on a strip-mine haulage truck, dust accumulations in the preparation plant—all these are examples of potential accidents that can be headed off by good plant maintenance. In this connection, the plant includes all real

CLEAN EQUIPMENT, clear roadways, good rockdusting, adequate roof support mark top-drawer safety maintenance in underground workings.

CLEANLINESS AND GOOD ORDER can be maintained in the interest of safety if care is taken in designing the plant to permit washing down.

STRIP-MINE ROADS are safest when well-drained and graded, and when dust-allaying treatment in dry weather improves visibility.

estate, above and below, and equipment.

The steps through which this safety maintenance is achieved are the old standbys—inspection, reporting, repairing and following through. It is to be noted here that all technical and operating departments have a safety function, inasmuch as each is responsible for some degree of inspection and repairing.

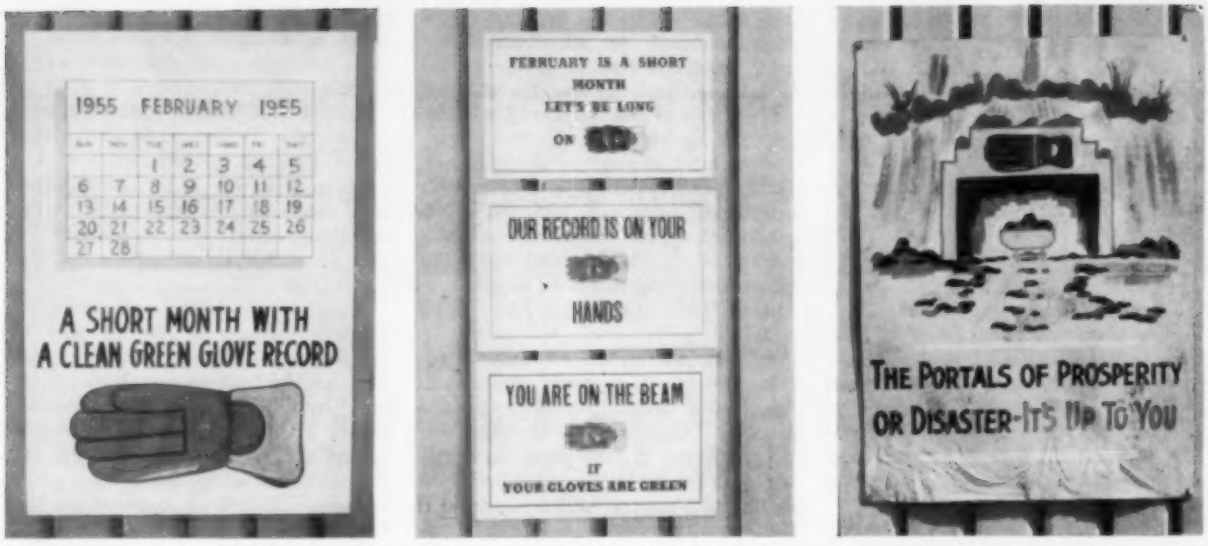
Some larger companies, employing full-time safety inspectors, have set up hard-and-fast rules on clearing up hazardous conditions. The inspector at the end of his visit leaves at the mine or plant a list of the hazards and violations of good practice he has found. Copies of this list are filed in the safety department and with the operations chief. Mine officials are required to take appropriate action to remedy the condition, then report their actions through proper channels to the chief of operations. If such a report does not come up within a specified time, the safety department and chief of operations begin to ask questions. The system insures follow-through on safety-department recommendations.

DEEP MINES

The most important elements in maintaining a deep mine in safe condition are roof support, methane control and dust suppression. Falls of roof, rib and face still are the No. 1 killer, although a striking improvement under bolted roof is now in the records. The most promising remedies are closer supervision, strict compliance with timbering standards and bolting patterns, and better trimming of overhanging brows and loose coal. These are the only possible solutions to the problem as long as men are needed at the face.

Efficient ventilation also is safe ventilation. Proper methane control demands that sufficient air at reasonable velocity be moved past active faces to dilute and sweep away the gases issuing from the coal. Maintenance of physical plant in the interest of safety demands that bleeders, if they are part of the mining plan, be kept open, that stoppings be sealed against leakage and that airway obstructions be removed. Effective gas detectors also must be considered as safety maintenance tools.

In underground dust suppression the big guns are rock dust and water sprays. The latter may be wetting agents. Recent developments in rock-dusting machinery now permit in-cycle distribution, even at today's faster pace. A new machine forces 30 lb per min through 400 ft of 2-in



GREEN LEATHER GLOVES are given to safe workers by a West Virginia company which hangs an entire safety-promotion campaign on these eyecatching symbols. An immediate reduction in frequency rates was noted.

hose. The rock dust may be discharged through a wetting nozzle, if desired. The basic unit is only 15 in high, making it usable in the thinnest seams. Taking another approach, a coal company designed its own equipment for mixing rock dust with water and applying it wet (*Coal Age*, February, 1955, p 82).

Whatever the methods, however, the main point is that the rock dust should be evenly distributed, in back headings and returns as well as in more active places. Rock-dust barriers may be included in the overall plan, and the importance of loading out excessive accumulations of coal dust should not be overlooked.

In all instances, maintenance of a safe plant requires the establishment of fire-fighting systems, including water lines, tested firehoses and chemical extinguishers, where needed. First-aid supplies should be provided in clean, well-lighted rooms, and self-rescuers sufficient for the men in the areas should be placed in caches in strategic underground locations.

IF A SLOGAN CONTEST IS HELD the winning slogan should be plugged for all it's worth, as this Ohio company does with its winners on dipper stick.

STRIPPING

In stripping, safety maintenance is primarily a matter of equipment maintenance. A schedule for wire-rope changes should be worked out, since each unexpected rope failure is a potential accident. Haulage trucks must be kept in good condition to head off steering and brake failures particularly. Well-drained smooth-surfaced roads may eliminate dangerous skids, and in dry weather road surfaces should be sprinkled or treated with dust-allaying chemicals for better visibility.

Truck spotters must be properly trained to stay out of the way of backing trucks and out of close clearances around dump ramps. They should also be competent in keeping drivers out of trouble near the edges of spoil banks. Safety in the pit-distribution of high-voltage electricity must be a primary concern of top management through the chief electrician.

PREPARATION

In preparation plants, particular check points for safety inspectors are dust accumulations on beams, housekeeping in the oil-storage area, clean-up precautions before any welding is done, open gearing, exposed wiring, overhead obstructions and so on.

The possibility of using paints of different colors in the plant might be weighed. For example, standard colors for safety include red for fire exit signs and fire equipment; orange on the inside of movable machinery guards and exposed edges of pulleys, gears, rollers and so on; yellow for handrails, top and bottom steps and caution signs; green for first-aid equip-

ment; and black and white for traffic lanes and direction signs.

One final requirement, if all this maintenance is to be meaningful, is that workmen wear proper articles of protective clothing and refrain from wearing loose clothing.

Keeping Interest Alive

Ill-advised incentives may not set back the cause of safety but they can be a waste of time for the safety department. A decision to adopt or reject a proposed incentive must be based upon thorough study, with local conditions and personalities weighing heavily in the final judging.

Strange as it may seem, safety bonuses for supervisors have not been an unqualified success in all quarters. The privilege of wearing a white safety hat for supervising a crew through an accident-free month may be more exciting. And even more worthwhile is some scheme where everyone participates in making a good record and shares in the acclaim.

A case in point is the experience at two mines where the supervisor and each workman on an accident-free crew receive a pair of green-colored all-leather work gloves trimmed in yellow each month the record is maintained. Simple, but effective! Frequency rates at the two mines during 1954, the first full year of incentive operation, were 48 and 50%, respectively, below the rates for 1952. An immediate improvement was noted when the program was adopted in August, 1953 (*Coal Age*, June, 1955, p 65).

Slogan contests are effective attention getters, if properly conducted. Application blanks may be distributed as payroll inserts. The response will be gratifying if the prize is worthwhile. Then interest and participation in the next contest will be assured if the winning slogan is widely promoted. One company, for example, has distributed winning slogans on bumper cards for employees' automobiles and displayed them on the company's huge stripping machines and in other places about the properties.

Once an incentive has been adopted it must be given a fair chance to succeed. But if it still fails to have the desired effect in creating enthusiasm or reducing accident rates, it must be summarily discarded. Permitting such an incentive to drag on with only half-hearted promotion may be mighty damaging to the entire safety program. Best practice in a situation like this is to have another idea ready to take the place of the incentive you must scrap, although the new idea should be one that has a better-than-even chance of succeeding.

Timely scheduling of refresher training sessions is another way of keeping safety interest at a high level. The accident-prevention training offered by the Bureau of Mines is practically a "must" at all mines because it has captured the interest of the men at mines where it has been given already. Follow-up sessions on this training are especially recommended.

One of the best ways to keep the safety program alive is to look for opportunities to reward individual achievements in safety. The recipients will be happy to have their achievements recognized, and the others will have their interest aroused. Notable individual safety records may be searched out at virtually every mine.

Help in Your Buying Operations . . .

1955 Mining Guidebook Issue

A COMPLETE CROSS SECTION of the modern equipment, materials and services offered by manufacturers and service organizations is presented in the following pages to round out this 1955 Mining Guidebook issue of *Coal Age*.

This Buying Directory and Buying Information section is designed to help you in three major ways:

1. If you need equipment, materials and services not previously used . . .

2. If you are interested in additional sources of equipment, materials and services . . .

3. If you are developing a new idea in production, preparation and safety and want to see what's available for carrying it out . . .

Check the Buying Directory beginning on p 197 of this issue. Find the product in the alphabetical list. Under it will appear the names of the key manufacturers, with those advertising in this issue indicated by black-faced type. Trade names also are included for convenience in identifying and selecting products.

Consult the manufacturers' advertisements in this issue for information on specific products, materials and services.

They are still burning coal over 450,000,000 tons of it, and that is a lot of coal.

Are you getting your share?

This is no time for static thinking. Your participation in the coal market is just what you make it—measured only by what you can give the buyer.

Look about you. Examine the sales record.

Whose coal is being sold?

Who designed, manufactured, and erected their preparation plants?

Why is their coal being preferred *over yours?*

Because they are delivering a better fuel—better washed, better screened, better dried, and are doing all this at a *lower cost per ton*. They are doing it for all of the country's great coal-consuming markets, and they are doing it with McNally Pittsburg-built plants.

Ask
the men who know coal
from the ground up

McNALLY PITTSBURG
MANUFACTURERS OF EQUIPMENT TO MAKE COAL A BETTER FUEL

McNally Pittsburg Manufacturing Corporation—Manufacturing Plants: Pittsburg, Kansas • Wellston, Ohio
Engineering and Sales Offices: Pittsburgh • Chicago • Rio de Janeiro • Pittsburg, Kansas • Wellston, Ohio

FIRST CLASS
PERMIT No. 93
(Sec. 34.9, P. L. & R.)
PITTSBURG, KANSAS

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

4c-POSTAGE WILL BE PAID BY—
McNally Pittsburg Mfg. Corp.
PITTSBURG, KANSAS

A Few of America's Leading Coal Producers

who are getting their share

OF THE 450,000,000 TON MARKET

Alabama By-Products Corporation
Alabama Power Company
Alaska Railroad Company
Alston Coal Company
Amherst Coal Company
Ayrshire Collieries Corporation

•

Beaver Coal and Mining Company
Bell & Zoller Coal & Mining Company
Bevier Coal Company
Blackfoot Coal & Land Corporation
Black Star Coal Corporation
Blue Diamond Coal Company
Boone County Coal Corporation
Broken Aro Coal Company
Brophy Coal Company
Butler Consolidated Coal Company

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Carmac Coal Company
Central Coal Company
Coal Processing Corporation
Coiltown Mining Company
Colonial Coal Mining Company
Columbian Southern Chemical Company
Crowe Coal Company

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Dawson Collieries
Dawson Daylight Coal Company
Delta Coal Mining Company
Dering Coal Company
Diamond Smokeless Coal Company
W. G. Duncan Coal Company

•

Eastern Coal Corporation
Eastern Gas & Fuel Associates
Emerald Coal & Coke Company
Ethel-Chilton Mines, Inc.

•

Fairview Collieries Corporation
Forsyth-Williamson Coal Company

•

Gaston Coal Company
The Dorothy Gordon Mining Company
Gulf Smokeless Coal Company
Guyan Eagle Coal Company

•

Hanna Coal Company
Homestead Coal Company
Hopkins County Coal Company
Hume-Sinclair Coal Mining Company

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Jewell Ridge Coal Corporation
Jones & Laughlin Steel Company
Julia-Ree Coal Company

•

Kaiser Steel Corporation
Ken Coal Company
Kentucky Sun Coal Company
Key Coal Company
Kirkpatrick Coal Company

•

Linton Summit Coal Company
Lone Star Coal Co., Inc.
Lone Star Steel Company
Lynnville Coal Company

•

Mahan-Ellison Coal Corporation
Marriott Reed Coal Company
Mather Collieries
The Maumee Collieries Company
Mid-Continent Coal Corporation
Middle Fork Coal Co., Inc.
Midland Electric Coal Company
Midwest Utilities Coal Corporation
Milburn By-Products Company
Montana Coal & Iron Company
Morgan Coal Company
Morgan Mines, Inc.

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New River & Pocahontas Consolidated Coal Company
Northeast Kentucky Coal Company
Northern Illinois Coal Company

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OK Coal Company
Old Ben Coal Corporation

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Palmer Coking Coal Company, Inc.
Paradise Collieries, Inc.
Peabody Coal Company
Pioneer Coal Company
Pittsburg & Midway Coal Mining Company
Pond River Collieries
Power Coal Company
Pyramid Coal Company

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Raleigh Wyoming Mining Company
Red Cedar Coal Company
Red Jacket Coal Corporation
Renton Coal Company
Republic Steel Corporation
Ridgeview Coal Company
Roslyn-Cascade Coal Company

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St. Louis & O'Fallon Coal Company
Sahara Coal Company
Scotia Coal & Coke Company
Seminole Coal Company
Shasta Coal Corporation
Slab Fork Coal Company
Sloss Sheffield Steel & Iron
Snow Hill Coal Corporation
Southwestern Illinois Coal Corp.
Sunlight Coal Company
Sunnyhill Coal Company

•

Tasa Coal Company
Tecumseh Coal Company
Ten X Coal Company, Inc.
Triple "S" Coal Company
Truax Traer Coal Company
Turkey Gap Coal & Coke Company

•

Union Collieries
United Electric Coal Company
United States Coal & Coke Company
United States Fuel Company
Usibelli Coal, Inc.

•

Valley Camp Coal Company
Viking Coal Company
Virginia Polytechnic Institute
Vogue Coal Company

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Winco Block Coal Company
Windsor Coal Company
Windsor Coal & Mining Company

•

Yates Coal Company
Youghiogheny & Ohio Coal Company

STATE YOUR PROBLEM HERE OR ON YOUR LETTERHEAD

I am interested in

☐ Washing_____" x 0 at_____tons per hour.

☐ Drying _____" x 0 at_____tons per hour.

Name_____Title_____

Company_____

City and State_____

( ) Have Sales Engineer call for further consultation.

( ) Send additional information.

CD

You, too, can compete—with better prepared coals—at lower cost per ton

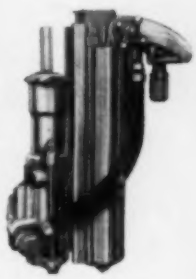
Ask

McNALLY PITTSBURG

MANUFACTURERS OF EQUIPMENT TO MAKE COAL A BETTER FUEL

The Men Who Know Coal from the Ground Up

McNally Pittsburg Manufacturing Corporation—Manufacturing Plants: Pittsburg, Kansas • Wellston, Ohio
Engineering and Sales Offices: Pittsburgh • Chicago • Rio de Janeiro • Pittsburg, Kansas • Wellston, Ohio



28" FEED

46" FEED

64" FEED

Remove Snap Ring

Remove Chuck

THE CLEVELAND S20 VAC-NU-MATIC STOPER

All models available in either SAV-A-CHANGE or Socket Type Chuck

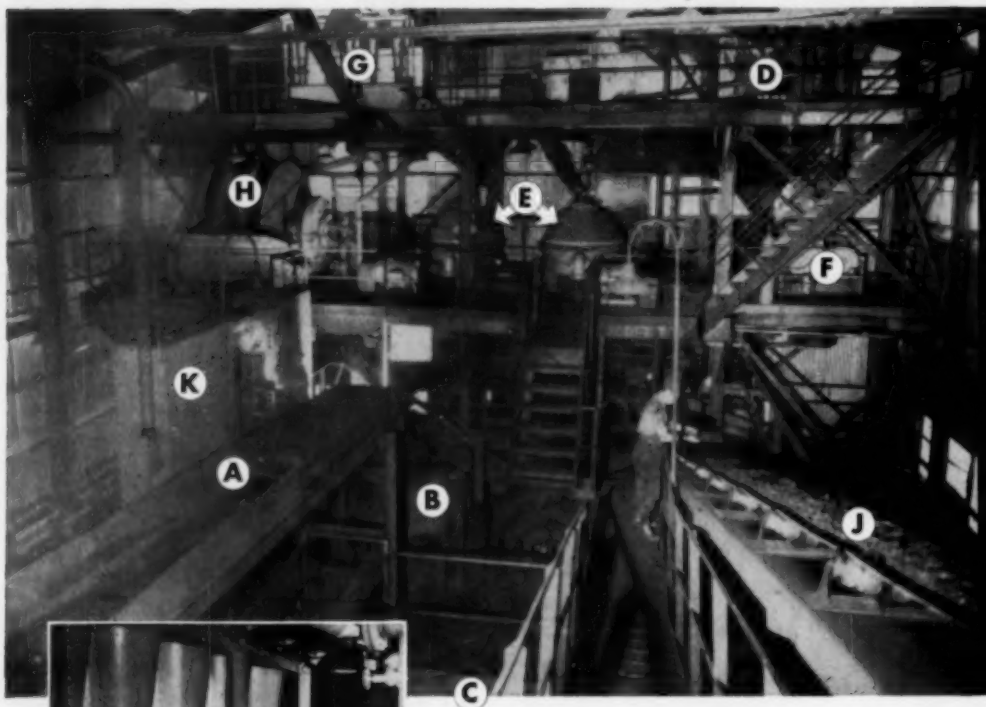
● The new CLEVELAND S20 VAC-NU-MATIC dust collecting stoper is available in 3 feed lengths to suit any working height down to a 26" seam. *It will produce a 30" hole in a 26" seam without using coupled steel.* The 28" feed weighs 69 lbs. complete. Any model may be used either hand held or jumbo mounted. VAC-NU-MATIC bits are fast and free cutting and eliminate all stuck steels. Dust collection is positive even in wet top. Chucks may be replaced without dismantling the machine, using only a pair of snap-ring pliers. Cuttings are removed at the chuck housing and do not pass through the machine. Write for bulletin RD32 or let us demonstrate in your own mine.

For sales, service, information or demonstration in Pennsylvania and West Virginia contact: Schroeder Brothers — 3116 Penn Ave., Pittsburgh, Pa. or Acme Machinery Co. — Williamson, W. Va. In the Birmingham district contact Equipment Service Co., 617 North 9th St., Birmingham, Ala., or contact us direct from anywhere.

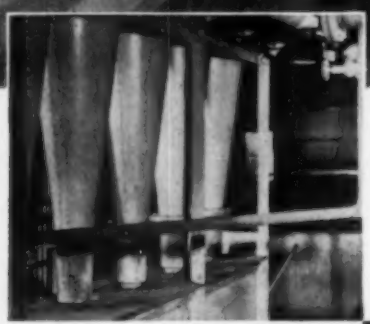
CLEVELAND ROCK DRILL DIVISION
Westinghouse Air Brake Company
12500 BEREA ROAD • CLEVELAND 11, OHIO

RD-75

ONE MAN OPERATES Westmoreland Coal Company's New Fine-Coal Washing Plant . . . Designed and Built by Heyl & Patterson



A. Raw Coal Feed Sluice
B. H & P 8 way Impulse Distributor
C. 8 Deister Tables (located on ground Floor)
D. Clean Coal Preliminary Dewatering Screen
E. 2 Reineveld 36" Fine-Coal Dryers
F. Cyclone Feed Pump
G. Five 14" H & P Cyclones
H. Vacuum Filter
J. Clean Coal Belt Conveyor
K. Control Panel for all Equipment

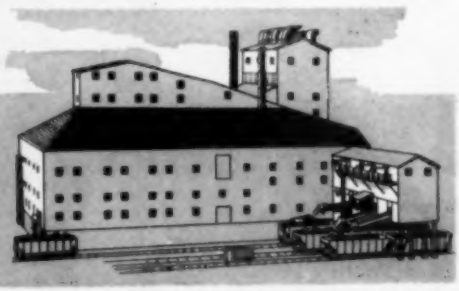


One man operation is possible because all operating units are visible from the operator's station. This modern plant processes 100 tons per hour of ⅜" x 0" raw coal feed. It recovers 100% of the clean coal from the tables because the coal circuit is completely closed. It produces a product containing 7½% surface moisture in the ⅜" x 0" size.

H & P Cyclones produce a slurry having 40%—50% concentration and containing—28 mesh solids (an ideal filter feed) at the rate of 15 TPH.

Two 36" Reineveld Fine-Coal Dryers produce 70 TPH of fine coal with a surface moisture of 4.5%—5.5%.

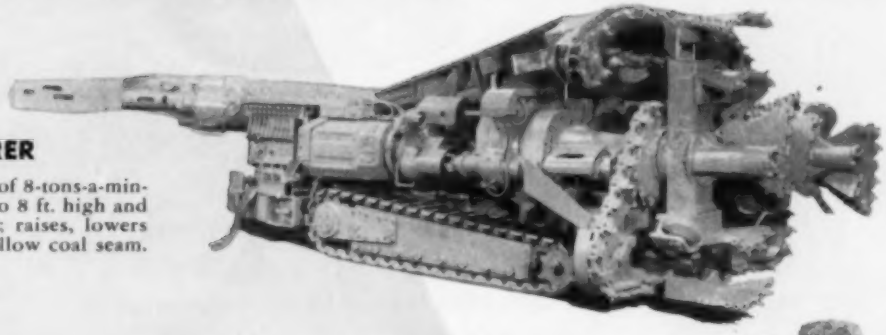
The raw coal feed is from the Irwin Basin of the Pittsburgh Seam. This Criterion Coal is sold by the General Coal Co., sales agents. Specifications called for clean coal of not more than 5½% ash and .9% sulphur. This H&P designed washing plant is consistently meeting these requirements.



Heyl & Patterson INC.

55 FORT PITT BLVD. PITTSBURGH 22, PA. PHONE COurt 1-0750

JOY'S LATEST FOR LOW-COST PRODUCTION

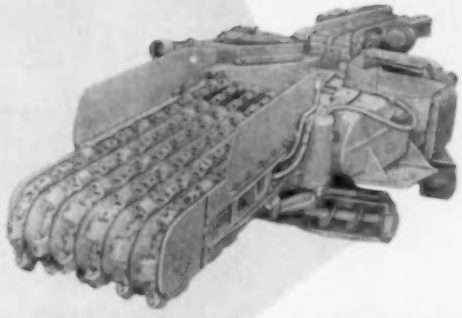


TWIN BORER

Full-face continuous miner of 8-tons-a-minute capacity. Cuts about 6 to 8 ft. high and 12 ft. wide. Self-propelled; raises, lowers and tilts hydraulically to follow coal seam. *Bulletin C-52.*

1-CM CONTINUOUS MINER

Heavy-duty, 4-tons-a-minute capacity unit; 45" high for seams 52" and higher. Cuts 5½" below to 90" above floor (120" with special equipment); available with two hydraulic roof drills of 4,200-lb. thrust, if desired. *Bulletin J-403.*

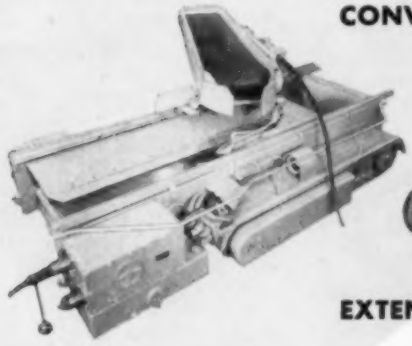


3-JCM CONTINUOUS MINER

Only 34" high overall for production in seams as low as 40". Rated capacity, 3 tons a minute. Cuts from 5½" below to 66" above floor (79" with special equipment). *Bulletin J-401.*

CONVERSION KITS AVAILABLE FOR OLDER 3-JCM MINERS

Brings older 6-chain and rotary head units up-to-date with 5-chain bars, G6111 chain, bevel gear drives for bar and conveyors, and mechanical-driven scroll cleanup that floats to conform to bottom.



EXTENSIBLE BELT CONVEYOR

Field-proved continuous haulage for distances up to 1000 ft.; extends or retracts 50 ft. at a time under full load. 24, 30 and 36-inch widths. Crawler-mounted drive (above) stores and pays out belt as needed. Crawler-mounted tail (left) provides a flexible connecting link to miner. *Bulletin J-303.*

LIMBEROLLER BELT CONVEYOR IDLERS

"The Idler with Flex Appeal"

Neoprene discs molded on flexible steel cable; only one bearing at each end, up out of the dirt. Special stands connect without cover sheets or bolts; can be added or removed without stopping belt. *Bulletin LD-103.*

Consult a Joy Engineer

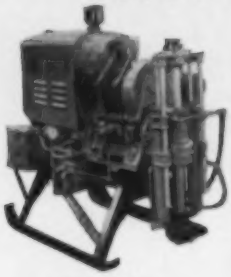
JOY

WORLD'S LARGEST MANUFACTURER OF MINING EQUIPMENT

HERE'S THE JOY LINE-UP

ABOVEGROUND

EXPLORATION
Deep and Strip Mines



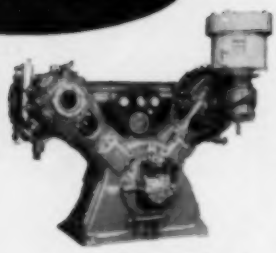
CORE DRILLS

Light, medium and heavy-duty for depths to 2000 ft. Gasoline, diesel or electric drives.

- DIAMOND BITS
- CORE DRILLING BY CONTRACT—skilled crews, complete equipment.

VENTILATING FANS

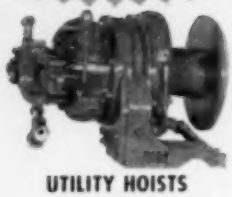
Adjustable-pitch blades, axial flow fans up to 12′ dia.; V-belt or direct drive.



STATIONARY AIR COMPRESSORS

Air or water-cooled; 2 to 3896 cfm; 30 to 600 psi.

SURFACE PLANT
Shaft or Slope Mines

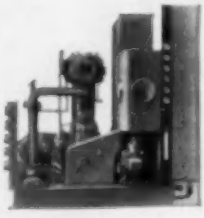


UTILITY HOISTS

Compressed-air, electric and gasoline drives; 750 to 5000 lbs. pull.

OXYGEN GENERATORS

Safe, low-cost oxygen plant, 9′7″ x 5′9″ x 10′ high, produces 2000 cfh of 99.5% purity.



PORTABLE LIGHTING

Safe power connections; choice of three light styles.

STRIP MINE
Anthracite and Bituminous

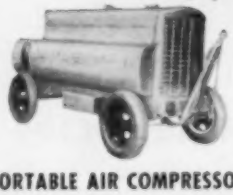
WAGON DRILLS

Light and medium-weight models for depths to 24′.

BLAST-HOLE DRILLS

Rotary and percussion; holes up to 12″; air, gasoline, diesel and electric drives.

Also: Core Drills, Oxygen Generators, Portable Lighting



PORTABLE AIR COMPRESSORS

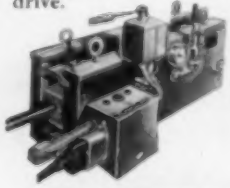
Models from 75 to 900 cfm; gasoline or diesel drive.

HORIZONTAL STRIPBORERS

Auger model, 4-6″ holes, 100′ depth; rotary air-blast model, 7⅞″ hole, 150′ depth.

ROCK DRILLS AND BITS

Hard-hitting drills with Dual Valves, cadmium plating. Efficient carbide bits.

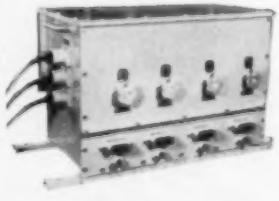


CABLE VULCANIZERS

Electric heat, steam or direct; automatic controls.

ELECTRICAL CONNECTORS

Factory-molded neoprene; shatter-proof, moisture-tight; flame, oil and acid-resistant.



SAFETY CIRCUIT CENTERS

Dust-resistant or permissible types; one through four outlets.

JOY PARTS AND SERVICE

"Genuine Joy Parts to Keep Your Joy Machine Genuine." Convenient stocking points in every mining area assure prompt delivery—often overnight, if necessary. Exeprienced Joy service men available in a matter of hours. These are "plus" values that really pay off in more efficient production and less down-time.

WRITE-CALL-WIRE FOR DETAILS ON ANY OR ALL OF THE ABOVE

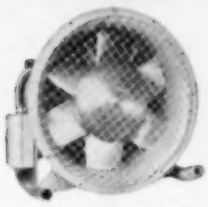
FOR EFFICIENT COAL MINING

BELOWGROUND

DEVELOPMENT
Anthracite and Bituminous

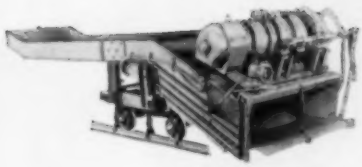
MINE-AIR COMPRESSORS

Two-stage units; models from 130 to 275 cfm; draw-bar or self-propelled; track or rubber-tire mounted.



PORTABLE BLOWERS

Equally suitable for low or high pressure; 5 sizes, varied drives.



SCRAPER LOADERS

For slopes up to 30°. 15 HP slusher, air or electric drive.

Also: Core Drills and Bits, Rock Drills and Bits, Fans, Rock Loaders, Drill Jumbos

PRODUCTION
Anthracite and Bituminous

EXTENSIBLE BELT CONVEYORS

Continuous haulage unit for continuous mining machines; 24, 30 and 36″ belt widths; portable LIMBEROLLER, 2-bearing, suspension idler system.

TWIN BORERS

Full-face machines with up to 8-tons-a-minute capacity.

CONTINUOUS MINERS

Ripper bar type; 34″ to 48″ heights; capacities to 4 tpm.

ROOF BOLTING DRILLS

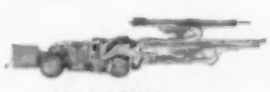
Hydraulic or pneumatic; fixed or swinging boom models.

CONVEYORS AND EQUIPMENT

Sections, drives, pulleys, takeups, feeders, wipers, idlers, etc.

CUTTERS

Shortwall, longwall, universal; track or tire mounted. Also bugdusters.



COAL DRILLS

Hydraulic or electric; track or tire mounted; one or two booms.

LOADERS

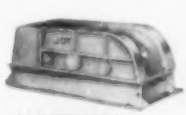
Eight models; 24″ to 87″ high; capacities 1½ to 12 tpm.

SHUTTLE CARS

Ten models; heights from 26″; capacities to 14 tpm; all drives.

MINING MACHINE TRUCKS

With and without cable reel.



CARPULLERS

Two models, draw-bar pulls equal to 15-ton and 30-ton locomotives.

ROOF-BOLTING STOPPERS

Collapsed lengths from 21″ to 33½″; steel changes from 14″ to 48″.

ELEVATING CONVEYORS

Track, tire or crawler mounted; capacities to five tons.

Also: Fans & Blowers, Augers, Postpullers, Timber Setters, Controllers, Cutter Bit Heaters, Bit Sharpeners, Cable Vulcanizers, Electrical Connectors, Power Distribution Systems, Portable Lighting Systems, Cable Fault Finders

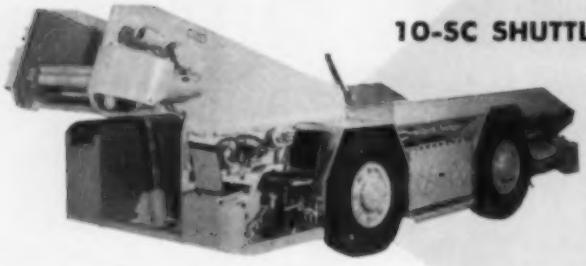
Consult a Joy Engineer

JOY

WORLD'S LARGEST MANUFACTURER OF MINING EQUIPMENT

JOY MANUFACTURING COMPANY • Oliver Bldg., Pittsburgh 22, Pa., GR 1-2140

OTHER JOY PRODUCTION EQUIPMENT

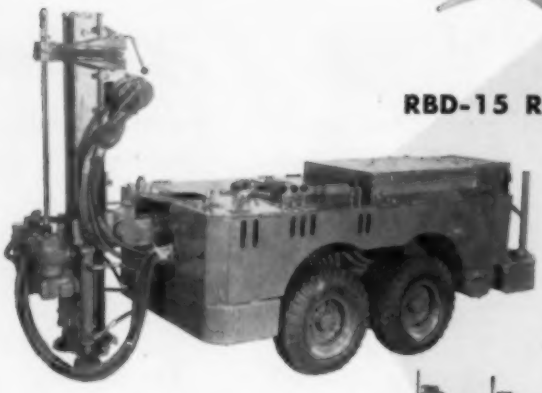


10-SC SHUTTLE CAR

Available as a permissible or non-permissible unit in 43", 39" and 55" basic heights; capacities to 10 tons. Handles coal or rock with equal ease; built for continuous, heavy-duty service; has 4-wheel drive, 4-wheel power-boosted steering, 4-wheel disc brakes, hydraulically adjustable elevated discharge. *Bulletin J-204.*

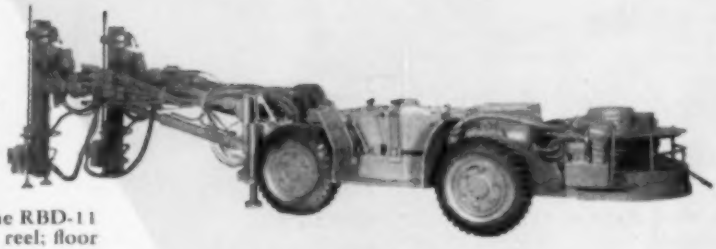
SUPER 14-BU LOADER

A beefed-up version of the Joy 14-BU, long the world's most widely-used loader for medium seam heights; has a maximum capacity of 10 tons a minute. Available in heights of 31½", 33" and 36"; has Joy's famous gathering mechanism and exclusive Magnetax control. *Bulletin J-111.*



RBD-15 ROOF BOLTING DRILL

Compact, self-contained, self-propelled, all-hydraulic rotary drill; has high maneuverability, great drilling power and unequalled flexibility in operation. Offers instant adjustment of infinitely variable combinations of thrust, feed speed, rotation speed and torque to meet variations in roof structure, etc. Turns in its own length for easy handling in tight places and quick positioning; built in heights of 33" and 37" for seams from 42" to 96" high. Available for wet or dry drilling. *Bulletin C-50.*



RBD-11 ROOF BOLTING DRILL

Twin-boom, tire-mounted, self-propelled; has the same efficient drill unit as the RBD-15, mounted on each of its two 9-ft., 4½-inch booms. Each boom swings 90° out, 25° in for a 23-ft. face drilling range. The RBD-11 is 42¾" high; has hydraulically driven cable reel; floor jacks for front-end stability. *Bulletin C-50.*

SURGEPRUF

Re-usable; require no skiving of hose and no special tools for assembly; can be retightened on job without disassembly; permit use of more abrasion-resisting rubber-covered wire braid hose. *Bulletin H-100.*

Consult a Joy Engineer

JOY

WORLD'S LARGEST MANUFACTURER OF MINING EQUIPMENT

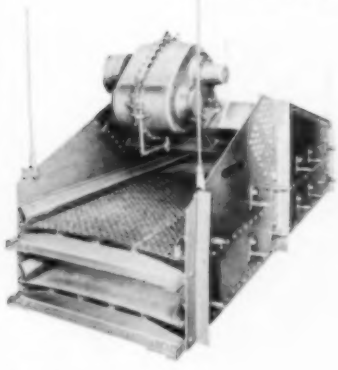
COAL PREPARATION EQUIPMENT

Included in the wide range of industrial products built by Allis-Chalmers are many used by the coal industry. Some of these are described in these four pages. For a complete list of Allis-Chalmers products and engineering literature, ask for Directory 25B6057. For further information on A-C coal industry products just mail the attached card.

Allis-Chalmers is leading supplier of VIBRATING SCREENS for coal

Open or Enclosed Types

The next time you need new vibrating screens—be sure to look into the Allis-Chalmers line, which includes a screen for every application. Allis-Chalmers has pioneered in the development of vibrating screens—engineering new improvements, designing new screens for specific applications.



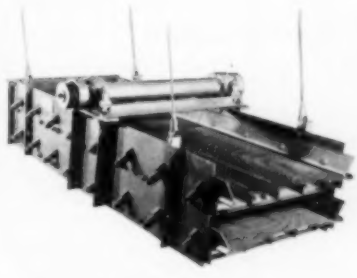
Low-Head screen

Low-Head vibrating screens operate horizontally, require considerably less head room than inclined screens . . . resulting in substantial savings in installation and remodeling costs.

These screens are constructed of high tensile strength alloy steels which combine lightweight and high strength. They can be suspended or floor mounted. Available with one, two or three decks with or without bottom plate. Sizes 3 x 6 to 8 x 16′. Send for Bulletin 07B6330A.

Ripl-Flo screens

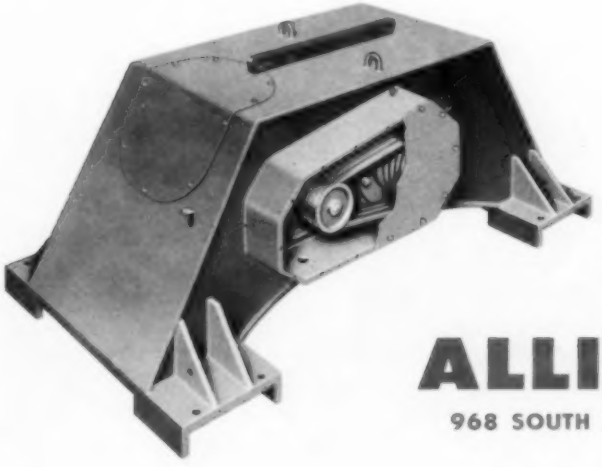
The *Ripl-Flo* screen is an inclined two bearing type screen with balanced vibrating mechanism that imparts a perfect circular vibratory motion to every point of the screen surface. Elimination of outer bearings and support frames reduces width 11% over comparable screens; weight by as much as 36%. Through unique side plate design single deck units can be changed to double deck units in the field. 1, 2 or 3 decks. Sizes from 3 x 6 to 6 x 16′. Bulletin 07B6151D.



Aero-Vibe screens

Aero-Vibe screens operate at a slope angle of 18 to 30° depending on tonnage, moisture content, amplitude of vibration and other variable factors. The vibrating mechanism, mounted above the screen, is a two bearing concentric shaft with adjustable offcenter weights for varying amplitudes. Easy to install and operate, *Aero-Vibe* screens require remarkably little maintenance. Suspended or floor mounted; one or two decks. Sizes 2 x 4 to 5 x 10′. 07B6099A.

SEE NEXT PAGE FOR ADDITIONAL INFORMATION ON COAL SCREENS



car shakers

The Allis-Chalmers Car Shaker unloads coal from hopper bottom Gondola car in as little as two minutes. The vibratory motion of the shaker is transmitted to the car and loosens the coal so it flows through the bottom openings. This means big savings in manhours and demurrage costs. The Car Shaker also eliminates the necessity for men to enter cars . . . is safe. Motor and drive are totally enclosed within the shaker body, protected from damaging weather. Multiple rubber shear mountings protect motor from vibration damage. Fits any width cars. Bulletin 07B7221A.

ALLIS-CHALMERS

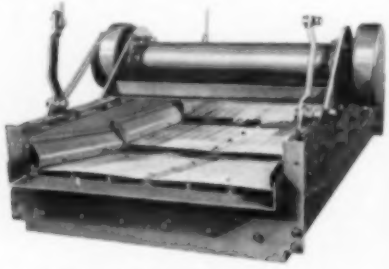
968 SOUTH 70th STREET • MILWAUKEE 1, WISCONSIN

25C6280H

vibrating screen SELECTION GUIDE for coal preparation plants

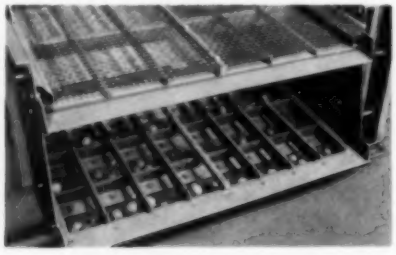
APPLICATION	FEED RANGE	SEPARATION	SCREEN	COMMON SIZES
Sizing ROM Coal & Rock Ahead of Crushers or Packing Tables	ROM	3" x 10"	Extra Heavy Duty *Ripl-Flo*	4' x 8' to 6' x 16'
Dry Sizing Raw Coal Ahead of Cleaning Units	4" to 8" x 0	10 Mesh to ½"	Standard or Special *Ripl-Flo*	4' x 10' to 6' x 16'
Wet Sizing Raw Coal Ahead of Cleaning Units	4" to 8" x 0	48 Mesh to ½"	Standard or Special *Ripl-Flo* or *Low-Head*	4' x 12' to 6' x 16'
Sizing & Dewatering Coarse Coal After Cleaning Units	4" to 8" x 10 Mesh to ½"	¼" to 4"	Standard *Ripl-Flo* or *Low-Head*	4' x 12' to 6' x 20'
Sizing Middlings After Cleaning Units	4" to 8" x 10 Mesh to ½"	¼" to 1½"	Standard *Low-Head* *Ripl-Flo* or *Aero-Vibe*	3' x 6' to 5' x 12'
Dewatering Refuse After Cleaning Units	4" to 8" x 10 Mesh to ½"	10 Mesh to ½"	Standard *Low-Head* *Ripl-Flo* or *Aero-Vibe*	3' x 6' to 5' x 12'
Media Recovery After Heavy Media Cleaning Units	3" to 10" x 10 Mesh to ½"	½ to 1½ Millimeters	Standard *Low-Head*	3' x 12' to 8' x 16'
Dewatering Fine Coal After Cleaning Units	⅜" to ½" x 0	¼ m.m. to ⅛"	Standard or Special *Low-Head*	3' x 12' to 6' x 20'
Sizing Washed & Crushed Coal	1½" x 0	⅜" to ⅜"	Standard *Ripl-Flo* or *Aero-Vibe*	4' x 8' to 6' x 16'
Dewatering Sludge—Solids Recovery	28 Mesh to ¼" x 0	¼ m.m. to 20 Mesh	Standard or Special *Low-Head* or *Aero-Vibe*	3' x 6' to 6' x 16'
Sizing Fine Coal After Dry Cleaning Units	⅜" to 1¼" x 0	28 Mesh to ⅛"	Standard *Aero-Vibe* or *Ripl-Flo*	3' x 6' to 5' x 12'

1 special RIPL-FLO screens for sizing damp coal



. . . with TRI-SLOPE deck

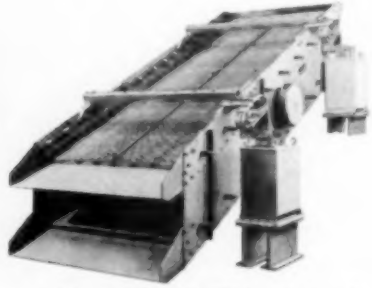
The *Tri-Slope* deck is designed to handle moist coal in ¾x0, ½x0 and ¼x0 sizes, and for screening and making separations of ⅛" round, equivalent of 10 and 14 mesh. Offers higher capacity than mechanical or electrical screens with conventional decks now used for this application.



. . . with STA-KLEEN deck

The *Sta-Kleen* screen deck consists essentially of a secondary deck located several inches below the screen cloth. It is divided into small compartments containing a patented oval rubber ball. Vibration of screen causes balls to bounce between retaining deck and screen cloth, dislodging particles that tend to stick to the wire cloth.

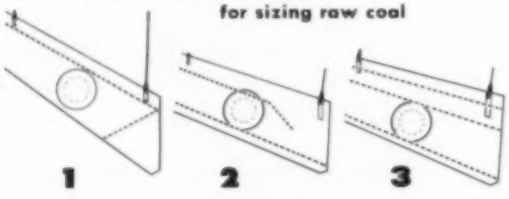
Bulletin 07R8354.



. . . with THERMO-DECK heating unit

The *Thermo-Deck* Heating Unit eliminates blinding when using fine mesh cloth for screening fine moist coal. It provides low voltage, high amperage resistance heating of cloth. This unit permits screens to operate continually without shutting down to clear the screen . . . greatly increasing the capacity. Bulletin 07B7812.

2 special design RIPL-FLO screens for sizing raw coal

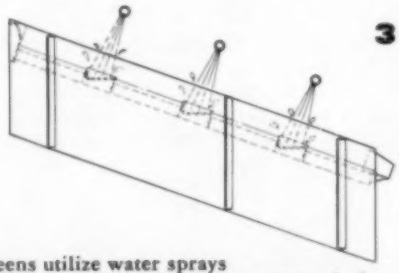


1 Screen equipped with reverse angle baffles at discharge end. Permits use of smaller hopper, saves headroom.

2 Double deck screen for reducing degradation when handling medium or soft structure coal. Eliminates separate discharge spouts on top deck . . . simplifies spouting . . . increases washer efficiency by removing maximum fines.

3 Use of multiple deck screen with each deck on a different slope (depending on size of coal and separation required) enables removing oversize lump coal on top deck, egg or range size on second deck, nut size on bottom deck.

3 special screens for wet sizing raw coal



Pool washing screens utilize water sprays directed to a succession of washing pools in screen deck. Result is a scrubbing process that puts fines into suspension for passage through screen surface. Pool washing screens increase screening capacity, save water. Bulletin 07B8214.

4 special screens for de-watering fine coal

Standard crowned decks can be used for dewatering fine coal. However, better dewatering is obtained by using flat type decks, since coal flows along the screen at an even depth. This eliminates tendency of fine coal to follow the sides or the crown, resulting in an uneven bed, preventing free drainage.

A DRIVE FOR EVERY MACHINE

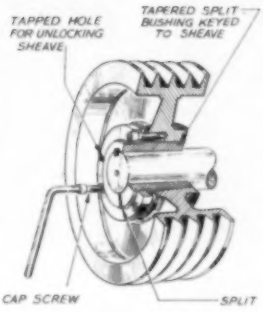
***Texrope*—greatest name in V-belt power transmission—is the registered trademark of Allis-Chalmers, originator and pioneer of multiple V-belt drives.**

Ask for Bulletin 20B6051, "Handy Guide to Selection of *Texrope* Drive Equipment"; it tells the complete *Texrope* Drive story . . . V-belts . . . sheaves . . . and how to figure a *Texrope* drive.

TEXROPE V-BELTS

Famous patented grommet construction provides longer life than ordinary V-belts. Made with straight sides for greater grip. Types for all operating conditions: heat-resisting; oil-resisting; static-resisting and special High Capacity. Also available: *Texrope* wide range V-belts for use with wide range *Vari-Pitch* sheaves and *Vari-Pitch* Speed Changers.

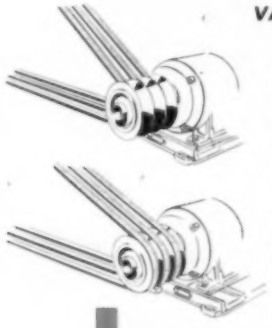
MAGIC-GRIP SHEAVES



The *Magic-Grip* cast iron sheave is designed for fast, easy mounting and demounting. Construction is simple, foolproof. Sheave can be installed or removed in shortest possible time. Cuts *maintenance* costs—reduces "down" time to minimum. It automatically adjusts itself to slightly oversize or undersize shafts. Positive clamp fit on shaft means no weaving—no vibration. There is no back lash—no extra play. Sheave can be mounted closer to motor or machine—reducing strain and stress. Result: bearing pressure *eased*—bearing life *increased*.

Entire sheave is smoothly finished, firmly fastened. No protruding bolts or set screws. Constant tension on cap screws means they won't work loose. Stock sizes for drives up to 150 hp. Larger sizes available on order.

VARI-PITCH SHEAVES AND SPEED CHANGERS



VARI-PITCH SHEAVES are available in two types; Standard Range for A, B, C, D or E belts—capacities from 1 to 300 hp—speed variations up to 38%. Wide Range for Q and R belts—capacities from 1½ to 40 hp—speed variations up to 100%. Both types designed with stationary or motion control features—Stationary Control for infrequent changes when sheave is stopped; Motion Control for repeated speed changes while sheave is in motion. Bulletin 20B6082.

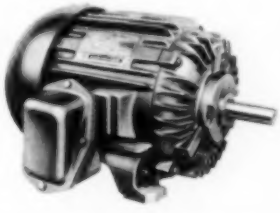
Vari-Pitch Speed Changers furnish 3¾ to 1 speed ratio in one compact, enclosed unit. Adjustable while in motion. Combines two wide range, worm gear-adjusted sheaves. Manual or pushbutton control. Bulletin 20B6013.

MOTORS FOR EVERY DRIVE

Allis-Chalmers builds a *complete* line of polyphase squirrel cage, wound rotor, synchronous, and direct current motors with electrical and mechanical modifications to meet *any application*. Ask for Bulletin 51B6052, "Handy Guide for Quick Selection of Electric Motors"; it furnishes you with enough facts on Allis-Chalmers motors to enable you to select the type which meets your required electrical and mechanical specifications. The next time you need an electric motor, contact your nearby Allis-Chalmers representative.

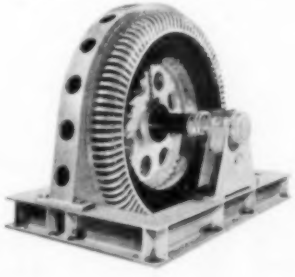
DRIP-PROOF

Small, tough, general purpose squirrel cage motors. All-around protection of inner parts. ½ to 200 hp and up. Also in splash-proof types. Bulletins 51B6210 and 51B7693.



ENCLOSED FAN-COOLED

Protected from dust, grit, vapor, gases. Cooling air circulated around exterior. ½ to 100 hp. Bulletin 51B7225. Also in new tube cooled type to 3000 hp. (51B7150).



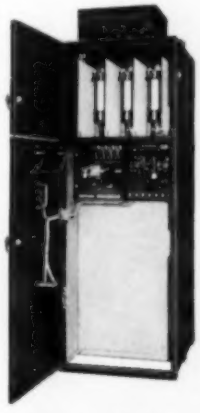
SYNCHRONOUS

High torque motors of constant speed, available in ratings of 40 hp and larger. End shield bearing types, Bulletin 05R-8183; pedestal bearing types, 05B7648, 05B7649; engine type 05B8008.

CONTROL FOR EVERY MOTOR

Allis-Chalmers makes a line of starters to meet practically all motor control needs. Count on this wide range of starters, backed by industry-wide application engineering experience, for the answer to your control needs. Ask for Bulletin 14B7733.

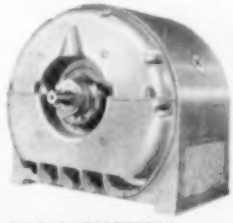
Bulletin 14B7132



Bulletin 14B6410

WOUND ROTOR

For adjustable varying speed service. High starting torque, low starting current. Bulletins 51B6052 and 05R8183.



LARGE INDUCTION

Drip-proof or splash-proof. 60 hp at 300 rpm to 2000 hp at 1800 rpm. Bulletin 05B7542. Ped. bearing types, 05B7771.

POWER AND ELECTRICAL EQUIPMENT

As a leading manufacturer of both steam and hydraulic power plant equipment, Allis-Chalmers is in a position to fill your complete requirements for turbines, generators, condensers, pumps, control equipment, etc.

And for power distribution, A-C has transformers, motor-generators, converters, rectifiers, metal-clad switchgear, switchboards, indoor and outdoor circuit breakers, etc.

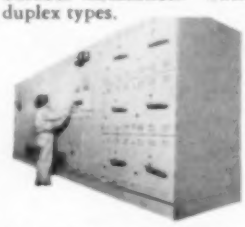
TRANSFORMERS

From the largest power transformers to instrument and metering transformers in a wide range of types and ratings. Dry-type transformers from 3 to 12,000 kva for installation right at load centers. Sealed dry-type available for mine use. Transformers also available with *Chlorextol* non-inflammable liquid for mounting indoors or on roofs.

SWITCHGEAR

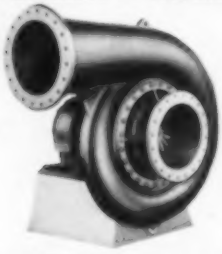
High and low voltage metal-clad and metal enclosed switchgear in all standard ratings to suit your particular requirements. Breakers for HV switchgear can be either oil or magnetic air types. LV switchgear uses either manually or electrically operated air breakers. Weatherproof switchgear is available for outdoor installation. Switchboards built to suit, in standard or duplex types.

UNIT SUBSTATIONS

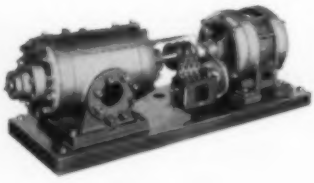


Completely factory built, unit substations can be installed indoors or out to provide power where you want it . . . to reduce cable costs and line losses . . . to provide better regulation. A-C substations can be built with any combination of HV and LV switchgear and oil, air or *Chlorextol* liquid cooled transformers to suit application. They can be equipped with rectifiers for reliable dc supply. Bulletin 11B6285 for load center units and 11B6935 for outdoor multi-circuit units.

BLOWERS - COMPRESSORS



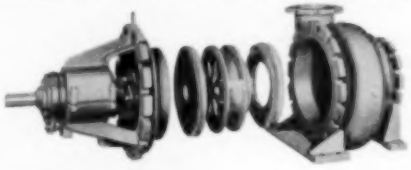
Centrifugal blowers are compact, light weight units with only one moving part. Four types available. Motor or turbine drive. Capacities to 130,000 cfm, pressures to 35 lb G. Bulletin 16B6048. Multi-stage blowers also available. Bulletin 16B6104.



Sliding vane type. Air is compressed in cells formed by blades moving freely in and out of longitudinal slots in rotor eccentric to its casing. Quiet, smooth operation. Units start unloaded. Capacities to 6000 cfm, pressures to 125 psig. Bulletin 16C8196.

CENTRIFUGAL PUMPS

More than 60 years' experience in designing and building centrifugal pumps goes to work for you when you specify Allis-Chalmers. This engineering background is your assurance of the *right* pump for your job! Whether your application calls for a single-stage or multi-stage pump, a pump to handle clear liquid, corrosive or abrasive liquids, or liquids containing high percentages of suspended solids, contact A-C for the *one* pump that will meet your particular requirements. Ask for "Handy Guide to Centrifugal Pumps," Bulletin 52B6059, for the story on the complete A-C line.



COAL WASHING PUMPS

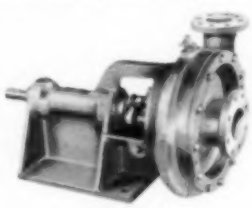
Developed by Allis-Chalmers especially for coal washing, the CW Solids pump handles up to 40 percent solids in suspension in slurries, tailing and sludges. Hundreds of applications have proved their economy.

Casing and working parts are made of a special, highly abrasion-resisting alloyed iron. Pump parts last longer . . . continue to deliver near rated capacity until completely worn. Rotating element can be removed without disturbing piping arrangements. Simplified design means easy maintenance—entire pump can be dismantled, worn parts replaced, and pump reassembled and back in operation in as little as ½ hour. Comparable size units of different ratings have interchangeable parts.

Built in eight sizes from 4 x 3 to 16 x 14 inches. Capacities from 175 to 10,000 gpm, heads through 140 feet. Through speed variations alone, A-C Solids pumps give the widest head and capacity range of any unit on the market. Bulletin 52B6381.

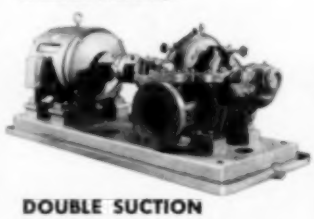
CLOSE COUPLED

With adapter between pump and motor to permit choice of motor sizes and types to meet practically any condition. Pump and motor operate on single shaft. Capacities 10 to 2500 gpm, heads to 550 ft. Bulletin 52B6083.



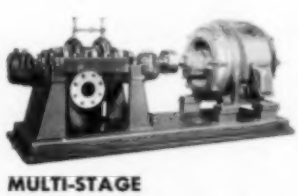
FRAME MOUNTED

Pump mounted on frame with separate shaft. Hundreds of standard ratings available, varying from 1 x ¾ to 8 x 6 in. Capacities from 10 to 2000 gpm, heads to 500 ft. Grease or oil lubricated. Bulletins 52B6351 and 52B7638.



DOUBLE SUCTION

Single-stage for general water supply, circulating or drainage. Coupling has *Magic-Grip* bushing for easy dismantling or assembly. 66 sizes from 2 x 1½ to 18 x 16 in. Capacities 30 to 7000 gpm, heads to 475 ft. Bulletin 08B6146.



MULTI-STAGE

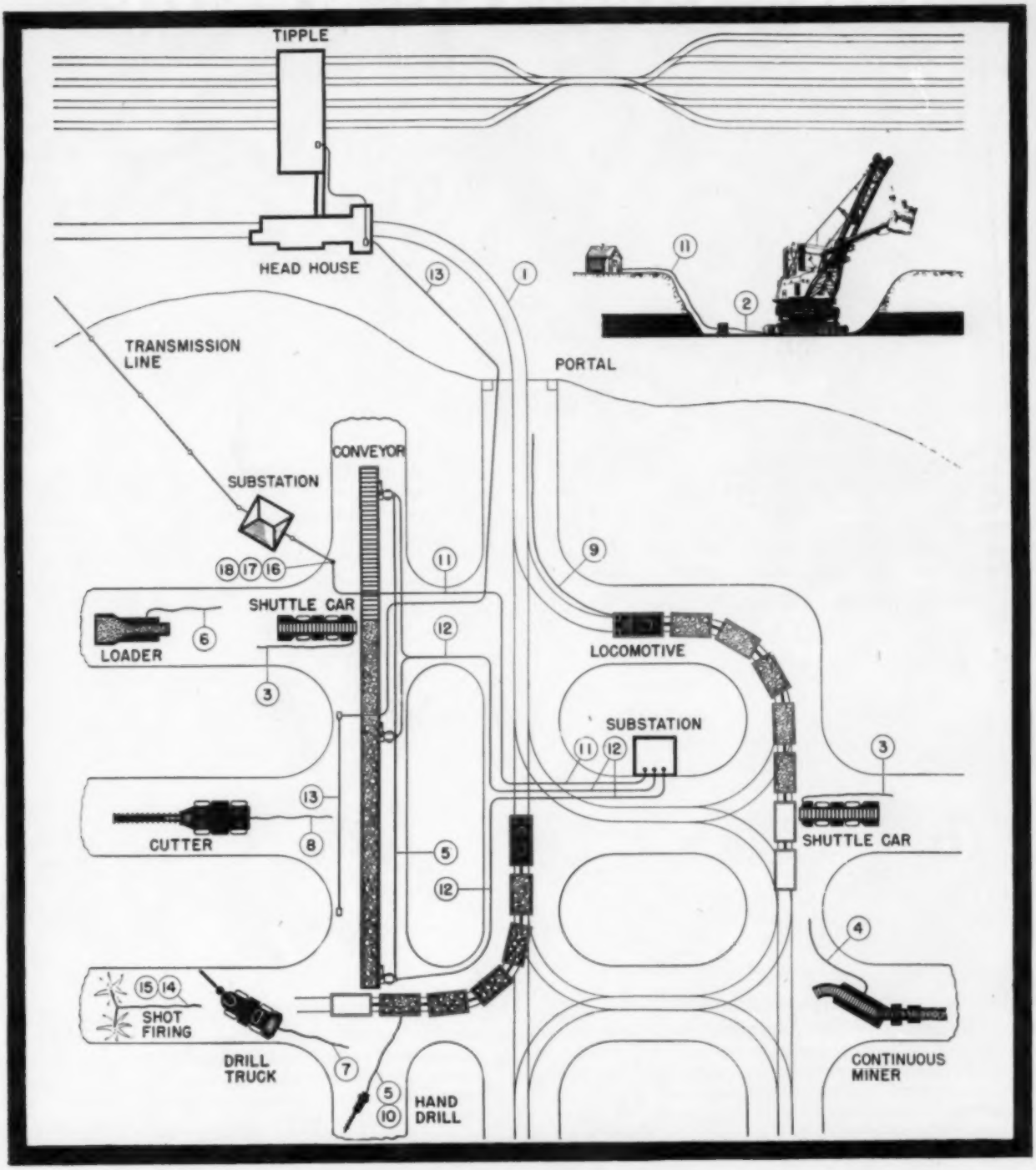
Single or double suction for clear liquids against high heads. For mine pumping, boiler feed pumping, general water supply systems. Another important use is hydraulic stripping of over-burden on top of mine or quarry.

Chlorextol, Electrifugal, Magic-Grip are Allis-Chalmers trademarks.

ALLIS-CHALMERS

968 SOUTH 70th STREET • MILWAUKEE 1, WISCONSIN

Litho in U.S.A. d-m



Choose your mine cable from this page

It takes a miner to understand mine problems.

And at Anaconda we're miners ourselves—as well as the world's largest manufacturer of mine wire and cable.

From tipple to mine face there are Anaconda wires and cables—designed, made and tested by mine cable experts—for *every* job in the mechanized mine. These wires and cables have proved records of safety and economy in mines all over the world.

Ask your Anaconda Distributor for these Anaconda products:
1) Trolley wire; 2) Shovel cable; 3) Shuttle-car cable; 4) Continuous mining-machine cable; 5) Remote-control and heavy-duty drill cord; 6) Loader cable; 7) Drill-truck cable; 8) Mining-(cutting) machine cable; 9) Gathering-locomotive cable; 10) Hand-drill cord; 11) Mine-power cable; 12) Low-voltage power and feeder cable; 13) Telephone cable; 14) Shot-firing cord; 15) Blasting-cap wire; 16) Borehole and mineshaft cable; 17) Anaconda suspension unit for borehole cable; 18) Armored cable suspension unit.

For more information, call or write Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y. 54343

ANACONDA®

968 SOUTH 70th STREET • MILWAUKEE 1, WISCONSIN

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COST-CUTTING MEMOS:

USE THE RIGHT EXPLOSIVES: Don't buy certain grades or types of explosives from force of habit! Possibly you can replace gelatins and semi-gelatins with equivalent-strength, and more economical, ammonium nitrate dynamites. Coal mines operating on short schedules should check economy of improved permissibles. Stripping and open pit operations may find greatest savings in cored ammonium nitrate explosives.

USE THE RIGHT TYPE CARTRIDGE: Fluted ends on cartridges (as with Apex® above) make for easier loading of both horizontal and vertical holes with no significant loss of compaction. Spiral winding protects against cartridge rupture. Loading crews are not held up by stuck cartridges. In underground operations, Redi-Slit® cartridges mean quicker and easier loading. The right type cartridge will cut costs.

SELECT THE PROPER POINT OF INITIATION: There is much misinformation and superstition on this subject. However, many open pit operations are effecting important savings by initiating blasts at the point of maximum confinement—normally the bottom of each hole. Not only is explosives efficiency increased, but excessive air blast is avoided . . . as well as complaints and damage claims.

KEEP UP WITH THE LATEST TECHNIQUES: Blasting is continually being improved. See that your men are using the methods which work best in your particular operation. The men above are looking at "The Inside Story"—an Atlas technical movie—during their lunch hour. If you'd like to show this movie to your men, simply write us on your company letterhead. We'll arrange a showing for you at an early date.

YES, you *can* cut costs with better blasting. Better blasting is simply a combination of the right explosives plus the right methods . . . for your job. Talk with your Atlas representative. Let him examine your blasting problems. He may have some ideas which can mean real savings in your particular operation.

And send us the names of the men you'd like to receive "Better Blasting." This free, informative periodical is published quarterly by Atlas to bring you technical tips and product announcements.

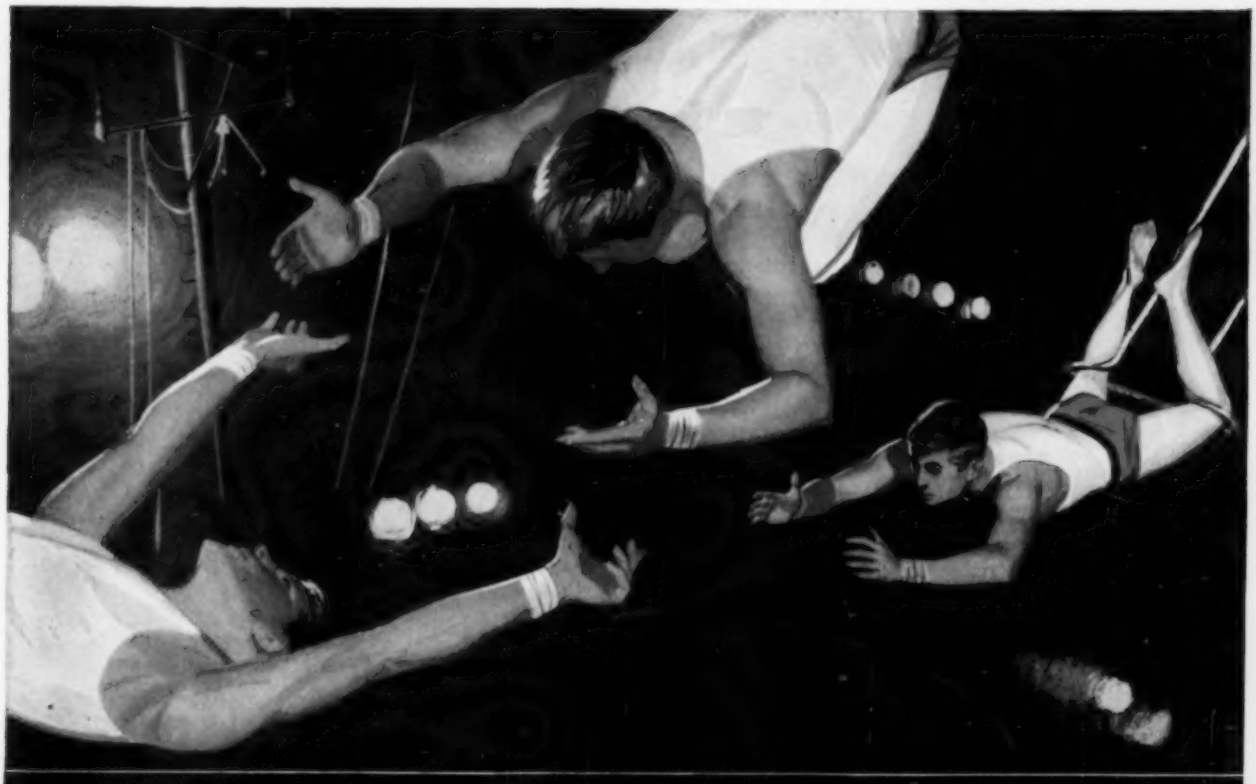
ATLAS

ATLAS EXPLOSIVES

"Everything for Blasting"

ATLAS POWDER COMPANY,
WILMINGTON 99, DELAWARE

Offices in Principal Cities



TOPS IN TEAM WORK—ALL THREE

each does a special job

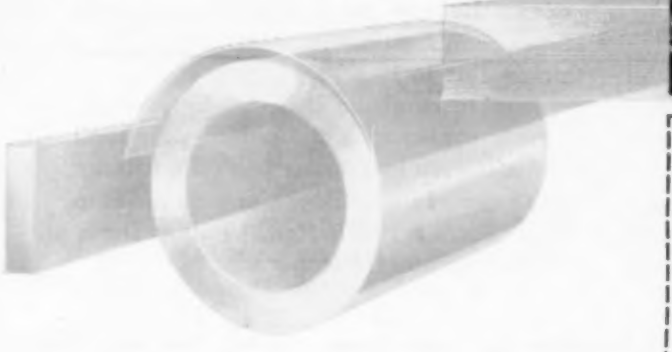
J&L's JALTEN series offers you three top performing high strength, low alloy steels with the following characteristics:

JALTEN NO. 1—High strength, good formability and fabricating—good resistance to low temperature impact.

JALTEN NO. 2—High strength, moderate forming—improved resistance to atmospheric corrosion.

JALTEN NO. 3—High strength—improved abrasion resistance.

J&L STEEL



SEND FOR THIS NEW BOOK:

Chemical properties of Jalten
Mechanical properties of Jalten
Jalten equivalents
Jalten application data

Jones & Laughlin Steel Corporation
Dept. 411—3 Gateway Center
Pittsburgh 30, Pennsylvania

Please send a copy of your Jalten booklet, *JALTEN LOW-ALLOY, HIGH-STRENGTH STEEL.*

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

Jones & Laughlin
STEEL CORPORATION — *Pittsburgh*

NEW SUPER RAYNILE CONVEYOR BELT 400% STRONGER

Provides the economical answer to transporting coal and other bulk materials over long distances and up steep slopes.

This remarkable new Hewitt-Robins conveyor belt reinforced with the revolutionary synthetic fabric, Super Raynile, makes possible an entirely new concept in single-section conveyor application. It solves difficult materials handling problems where topography and other conditions require the use of a long single-length conveyor.

Already in service, Super Raynile has the highest operating tension of any conventional carcass belt. Because of its tremendous tensile strength, 400% greater than conventional cotton reinforced belts, a single conveyor section *5¾ miles long* can be built over level terrain to carry material at 400 TPH using only a 6-ply Super Raynile belt 30 inches wide. This same belt can also lift material from ground level to a height of 830 feet.

The new Hewitt-Robins Super Raynile conveyor belt is highly flexible and pliable despite its great strength. Its cost is less than steel-reinforced belts and Super Raynile can easily be spliced in the field more quickly, more economically and without the specialized equipment required to splice steel-reinforced belts.

Super Raynile belt is available in a wide range of specifications . . . widths up to 72" — thickness up to 15 plies.

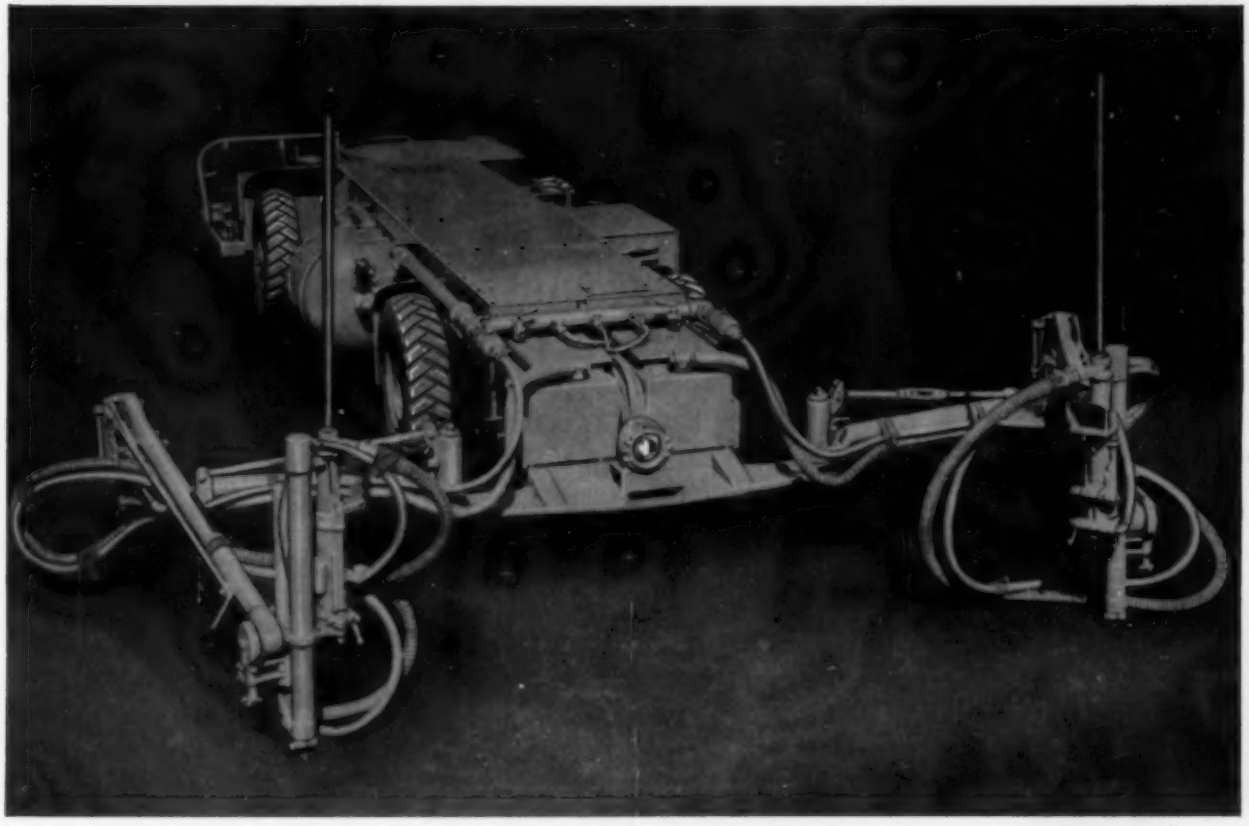
Learn more about this new long-length, long-life conveyor belt. Contact your local Hewitt-Robins Industrial Supply Distributor (see Classified Phone Book), or write direct to "Super Raynile Belt", Hewitt-Robins Incorporated, Stamford, Connecticut.

Hewitt-Robins

Conveyor Belting—Industrial Hose—Conveyor Machinery—Vibrating Screens—Vibrating Conveyors—Design, Manufacture, Engineering and Erection of Complete Bulk Materials Handling Systems.

HEWITT-ROBINS INCORPORATED • STAMFORD, CONNECTICUT

Acme adds 275 Compressor to JUMBOLTER...*for fastest most efficient roofbolting*



SUPER JUMBOLTER NOW AVAILABLE IN ONE COMPACT, SELF CONTAINED UNIT

It's Acme's newest contribution to better, faster, safer mining. Super Jumbolter combines all the advantages of the original Jumbolter plus a 2-stage 275 CFM compressor.

New Super Jumbolter saves time and working space. No need for separate portable compressor —no air lines to get in the way—just move your Super Jumbolter in and start bolting.

Jumbolter stopers put in bolts more than three times as fast as ordinary methods. It can work an area 23′ 10″ wide from one location. Air-articulated arms reach out 9′ in front of machine, swing in a 270° arc. Overall heights from 21″ permit bolting any roof from 36″ to 9′ in height.

The new Jumbolter has a unique built-in dust collection system. It does not remove (or pass) the cuttings through the body of the machine, nor does it use any type of external hood, or dust collection tube. Cuttings are removed through the side of the chuck housing immediately after they leave the drill steel. They are collected from the face through holes in the bit and down through the center of the drill steel.

Write today for new descriptive folder showing the many advantages of Acme's new Super Jumbolter.

ACME Machinery Company

PHONE 2274 WILLIAMSON, WEST VIRGINIA

Be sure to look over this issue from cover to cover

Every section has ideas which might help you:

- Deep Mining Guidebook
- Strip Mining Guidebook
- Preparation Guidebook
- Maintenance Guidebook
- Supply Service Guidebook
- Safety Guidebook
- Advertisement
- Buying Directory

Know where to find them

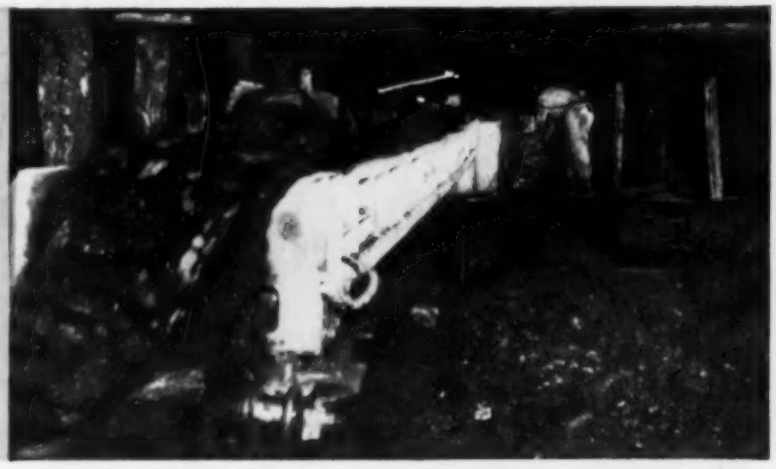
When buying, or requesting product information, please be sure to mention

Coal Age Mining Guidebook and Buying Directory issue

Whatever the operating conditions . . .

High Coal

In 44″ to 48″coal at a West Virginia mine, a six-man face crew has consistently produced over 40 tons per man-shift with the LONG Piggyback* Conveyor System (utilizing loading machine, two Piggyback conveyors, and LONG room conveyors).



Or . . .

Low Coal

With LONG Piggyback Conveyor Continuous Haulage Mining, loader crews at this Kentucky mine get 25 tons per man, conveyor moves included, in 30″ to 36″ coal. Photo shows LONG Pigloader* loading machine in action at this installation.

You can produce far more tons per man-shift at far less cost per ton with

LONG PIGGYBACK® CONVEYOR

CONTINUOUS HAULAGE MINING

The fastest growing method of mining in the United States

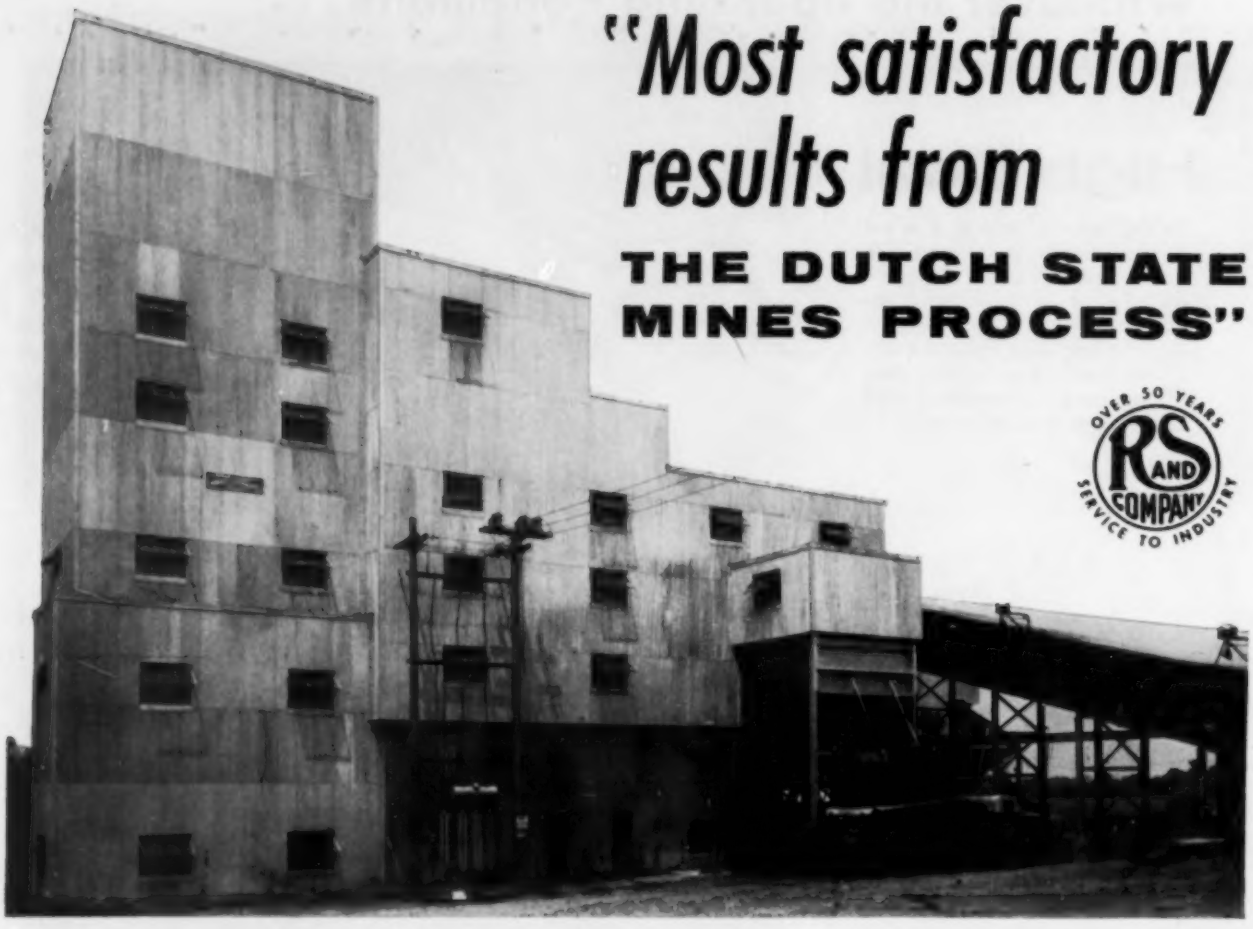
It's a proven fact that conveyor haulage with the LONG Piggyback Conveyor System is the practical, economical answer to the problem of true continuous haulage mining. With this exclusive LONG development, coal is moved from the face in a steady, constant flow with no delays for car or buggy changes. Whatever your operating conditions, low-maintenance, low-investment Piggyback Conveyor Mining can increase your production . . . decrease your costs.

Write today for details. *Trade Mark

The LONG Company
OAK HILL, W. VA.

Developers and exclusive manufacturers of the Piggyback Conveyor System

"Most satisfactory results from THE DUTCH STATE MINES PROCESS"



Dutch State Mines heavy medium process showing the static pool vessel and flights removing pure coal.

Pure coal after the final rinse.

says Frank Nugent, Executive Vice President, Freeman Coal Mining Corporation, speaking of his experience with the Dutch State Mines heavy medium separation process installed by Roberts & Schaefer in Freeman Mine No. 4 Williamson County, Illinois.

Freeman had approached R & S engineers with the problem of obtaining high quality coal from their new mine operating in the quality circle in Southern Illinois. This was the perfect application for the recently acquired Dutch State Mines process. With more than 50 years of coal preparation plant experience, including the designing and building of the most modern washing equipment for normal coal preparation, Roberts & Schaefer had realized that the trends required more precise cleaning. They had, therefore, secured the franchise to market the Dutch State Mines process in the United States. R & S were ready. Freeman needed the best coal washing equipment in the world—and they got it!

The plant has now been in operation for over six months and has thoroughly proved its efficiency; in fact, results are far better than were originally thought possible. As a result, Freeman is producing quality coal for quality customers.

Do you have a washing problem that is unusually severe? Possibly the Dutch State Mines process is what you need to solve it. Phone, wire or write for consultation.

ROBERTS and SCHAEFER COMPANY

SUBSIDIARY OF THOMPSON-STARRETT COMPANY, INC.

ENGINEERS AND CONTRACTORS

130 North Wells Street, Chicago 6, Illinois

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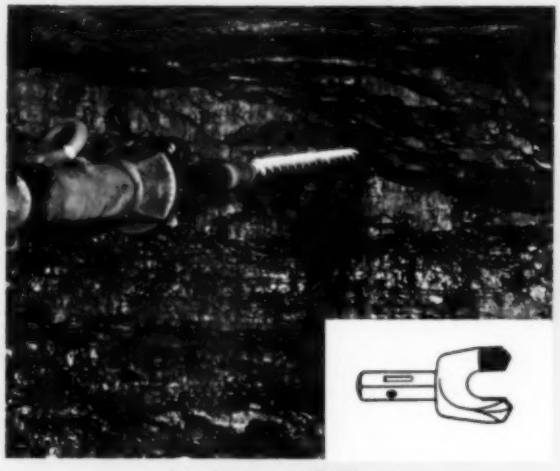
THERE IS A KENNAMETAL BIT FOR EVERY MINING OPERATION

Cutter Bits

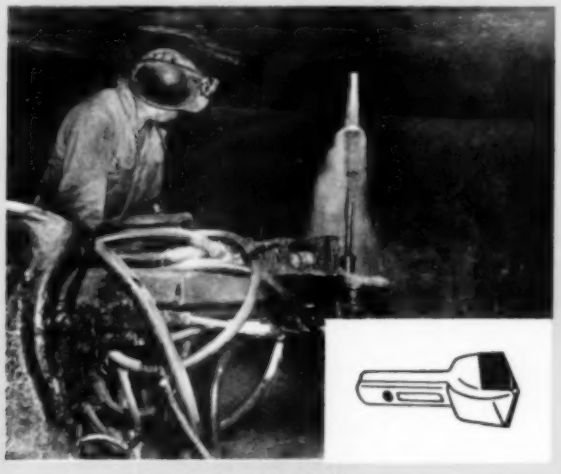
KENNAMETAL*
MINING TOOLS
for cutting...
for drilling



Bits for Auger Drilling

no other carbide lasts so long...
needs so little reconditioning...
causes so little strain on equipment...
costs so little per ton

Tool performance is measured best by the bit cost per ton. Cost is the end result of the quality of the bit. Kennametal bits are always of top uniform quality *because* Kennametal is able to maintain constant, rigid quality control of every step in the production of tungsten carbide bits from the moment ore is mined through each complex phase of refining the ore and of manufacturing the bits.



Bits for Roof Drilling

INDUSTRY AND

KENNAMETAL

...Partners in Progress

*Registered Trademark

IT WILL PAY YOU TO TRY KENNAMETAL BITS IN YOUR MINING OPERATIONS

AVAILABLE A KENNAMETAL

KENNAMETAL Cutter Bits

KENNAMETAL Mining-Machine BITS combine hard, cemented carbide cutting edges with a bit body of the highest quality steel, heat-treated to the correct hardness for machine operation. Special design and tough shank construction provide top coal cutting efficiency at higher speeds, with exceptionally long service life. Self-gaging prevents the bit from being driven down into the machine bit block. Savings in production time, fewer bit changes, lower power consumption, less machine maintenance add up to reduced cost per ton of coal. Ask your local Kennametal Representative to show reports of top performances enjoyed by coal operators everywhere with Kennametal Cutter bits.

Style "U" Bits

Cat. No.	Dimensions			
	G	X	Y	L
U-1	1½"	½"	1"	3⅜"
U-1H				
U-4	1¾"	½"	1"	4"
U-4H				
U-7	1¾"	½"	1"	4"
U-8	1½"	½"	1"	3⅜"
U-9	1⅜"	⅞"	1⅜"	3⅞"

Style "UR" Bits

Cat. No.		Dimensions			
Tip 3/16" Thick	Tip ¼" Thick	G	X	Y	L
U1R3		1½"	½"	1"	3⅜"
U4R3		1¾"	½"	1"	4"
U6R3	U6R4	2½"	¾"	1¼"	3⅜"
U7R3	U7R4	1¾"	½"	1"	4"
U8R3	U8R4	1½"	½"	1"	3⅜"
U9R3	U9R4	1⅜"	⅞"	1⅜"	3⅞"

KENNAMETAL Drill Bits

Designed especially for drilling both coal and rock, Kennametal Drill Bits provide long drilling life at low cost per ton. Even in successive layers of boney, clay, slate, shale and other hard impurities, the sintered carbide cutting edge withstands hard, tough service. And drilling can be continued for several shifts under average conditions, without time off for bit changing. Other features of Kennametal Drill Bits include fast chipping action, a rapid rate of penetration, and a smooth flow of cuttings.

Cat. No.	Dimensions		
	D	H	L
RD-1¼	1¼"	½" sq.	2"
RD-1⅜	1⅜"		
RD-1½	1½"		
RD-1⅝	1⅝"		
RDC-1¾			
D-1¾	1¾"		
DC-1¾			
D-1⅞	1⅞"		
DC-1⅞			
DS-1⅞	1⅞"	⅝" sq.	1½"
DD-1⅞	1⅞"	½" sq.	2"
DDC-1⅞			
DD-2	2"	⅝" sq.	2¼"
DDC-2			

Cat. No.	Dimensions		
	D	H	L
D-2¼	2¼"	⅝" sq.	2¼"
DC-2¼			
DB-2¼	2¼"	13/16" Hex.	
D-2½	2½"	⅝" sq.	
DC-2½			
DB-2½	2½"	13/16" Hex.	
DBC-2½			
DB-2¾	2¾"	13/16" Hex.	
DBC-2¾			
DBB-3	3"	1⅛" Hex.	3"
DBBC-3			

Styles DL and DBL are available in the same sizes and shank styles as regular D Style Bits, from 1¾" to 3".

KENNAMETAL Roof Bits

The design of Kennametal roof drilling bits and the selection of carbide grades for this service make possible the use of high thrust and torque to get holes through rock of various degrees of hardness and toughness without fracture of the cutting edges. Water ports are provided for cases where wet drilling is used. For more refractory work, Kennametal rock bits are supplied for use with stopers.

Style FDL

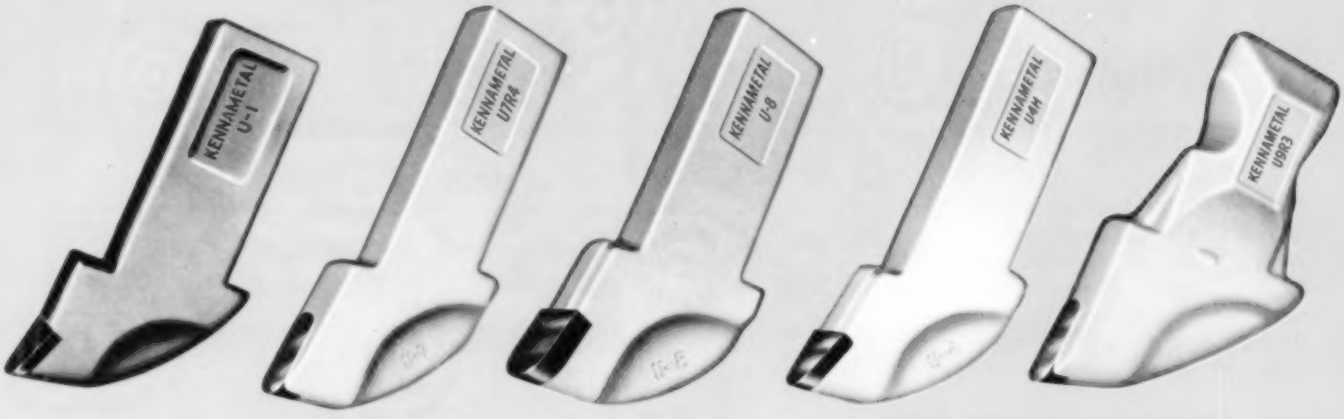
Cat. No.	Dimensions		
	D	H	L
FDL-1¼	1¼"	½" sq.	2"
FDL-1 5/16	1 5/16"		
FDL-1⅜	1⅜"		
FDL-1 7/16	1 7/16"		
FDL-1½	1½"		
FDL-1⅝	1⅝"		

Style FDH

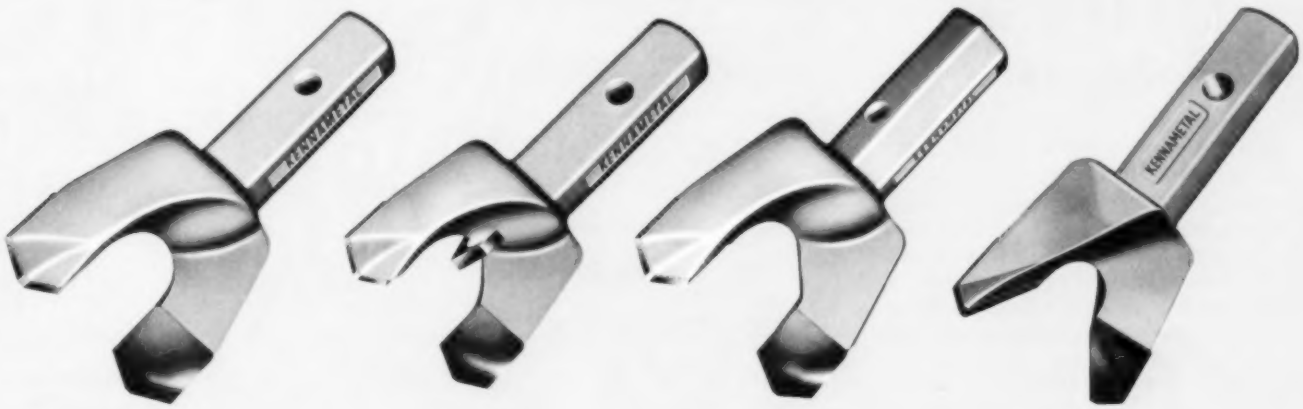
Cat. No.	Dimensions		
	D	H	L
FDH-1¼	1¼"	½" sq.	2"
FDH-1 5/16	1 5/16"		
FDH-1⅜	1⅜"		
FDH-1 7/16	1 7/16"		
FDH-1½	1½"		
FDH-1⅝	1⅝"		
FDH-1¾	1¾"		
FDH-1⅞	1⅞"	⅝" sq.	2¼"
FDDH-1⅞	1⅞"		
FDDH-2	2"		
FDH-2¼	2¼"		
FDBH-2¼	2¼"	13/16" Hex.	

THERE IS A COMPLETE LINE OF KENNAMETAL CUTTER BITS,

BIT FOR EVERY MINING NEED...



Style U1 | Style U7R4 | Style U8 | Style U4H | Style U9R3



Style D | Style DC | Style DB | Style DL

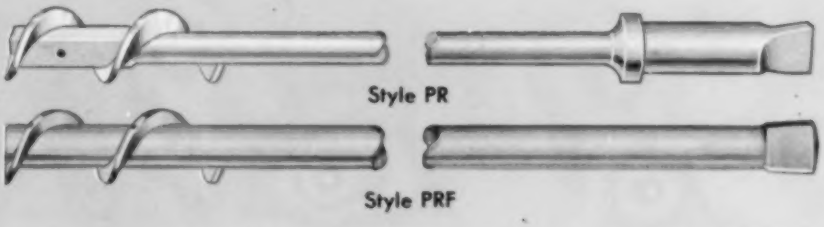
Style FDH | Style FDL | Style PA

DRILL BITS, ROOF BITS, AUGERS, PINNING RODS, ACCESSORIES

KENNAMETAL SPECIALTIES AND ACCESSORIES

KENNAMETAL Pinning Rods

These Pinning Rods are of special design to make roof bolting more practical wherever standard drills are used. Generally, the rod shanks are of the twist type to fit regular Kennametal Drive Sockets, but square and other types are made for special applications.



PR Rods with Twisted Shank		PRF Rods with Square Shank		PRX Rods (extension)		
Rod Length	Cat. No.	Rod Length	Cat. No.	Rod Length	Cat. No. ½" sq. Shank	Cat. No. ⅝" sq. Shank
2′	PR-2	2′	PRF-2	1′	PRXa-1	PRXb-1
3′	PR-3	3′	PRF-3	2′	PRXa-2	PRXb-2
4′	PR-4	4′	PRF-4	3′	PRXa-3	PRXb-3
5′	PR-5	5′	PRF-5	4′	PRXa-4	PRXb-4
6′	PR-6	6′	PRF-6	5′	PRXa-5	PRXb-5

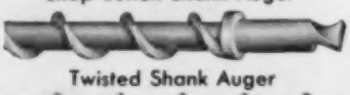
Other lengths in 6" multiples available.

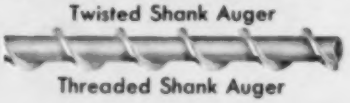
KENNAMETAL Augers

These augers are made of the highest quality steel available, giving them great strength and maximum resistance to bending. Life of the scroll is greatly increased by flame hardening during fabrication. Available styles of shanks: twist, threaded, and snap-button types. Smaller diameter augers have solid centers, while the larger diameters are tubular.

Also Kennametal Sockets, Studs, Couplings and Adapters.


Snap-Button Shank Auger


Twisted Shank Auger


Threaded Shank Auger

Style BR Socket

Snap-Button Shank Augers

Cat. No.		Dimensions	
3" long	4" long	D	C
SB13-3	SB13-4	1⅜"	½" sq.
SB14-3	SB14-4	1½"	
SB16-3	SB16-4	1⅝"	⅝" sq.
SB20-3	SB20-4	2"	
SB24-3	SB24-4	2½"	

Twist Shank Augers*

Auger Length	Cat.No. D=1⅜" C=½"	Cat.No. D=1½" C=½"	Cat.No. D=1¾" Stand-ard	Cat.No. C=⅝" H.Duty*	Cat.No. D=2" C=⅝"	Cat.No. D=2½" C=1⅜" Hex.
3 ft.	A13-3	A14-3	B16-3	BB16-3	B20-3	H24-3
4 ft.	A13-4	A14-4	B16-4	BB16-4	B20-4	H24-4
5 ft.	A13-5	A14-5	B16-5	BB16-5	B20-5	H24-5
6 ft.	A13-6	A14-6	B16-6	BB16-6	B20-6	H24-6
7 ft.	A13-7	A14-7	B16-7	BB16-7	B20-7	H24-7
8 ft.	A13-8	A14-8	B16-8	BB16-8	B20-8	H24-8
9 ft.		A14-9	B16-9	BB16-9	B20-9	H24-9
10 ft.			B16-10	BB16-10	B20-10	H24-10
Bit Sizes	RD-1⅜ RD-1½ FDH-1⅜ FDH-1¾ RD-1½	FDH-1⅜ RD-1⅝ D-1¾ D-1⅞	DD-1⅞ DD-2	DD-1⅞ DD-2	D-2¼ D-2½	DB-2¾

*Special Heavy-Duty Auger for use with high-powered drills. Augers with threaded couplings for long hole drilling are obtainable in the 16, 20, and 24 series by using the auger number above and specifying Acme threads and connecting stud CSA, and shank TRCSA.

H Augers (Hexagonal Chuck) are available for DB Bits.

Special Drill Series

Kennametal *Style FS* Finger Bits provide exceptional stamina and speed in drilling large diameter holes in hard rock.

The Kennametal Style SD bit is a three-pronged bit used in sizes from 3¾ to 9-inch diameter for drilling holes to blast overburden and for other special uses. The UD bit, for similar applications, uses replaceable cutters.


Style FS


Style SD


Style UD

INDUSTRY AND KENNAMETAL
...Partners in Progress

Mining Tool Division, Bedford, Pennsylvania
General Offices and Main Plant, Latrobe, Pennsylvania

YOUR KENNAMETAL REPRESENTATIVE IS LISTED IN THE CLASSIFIED TELEPHONE DIRECTORY UNDER MINING EQUIPMENT AND SUPPLIES

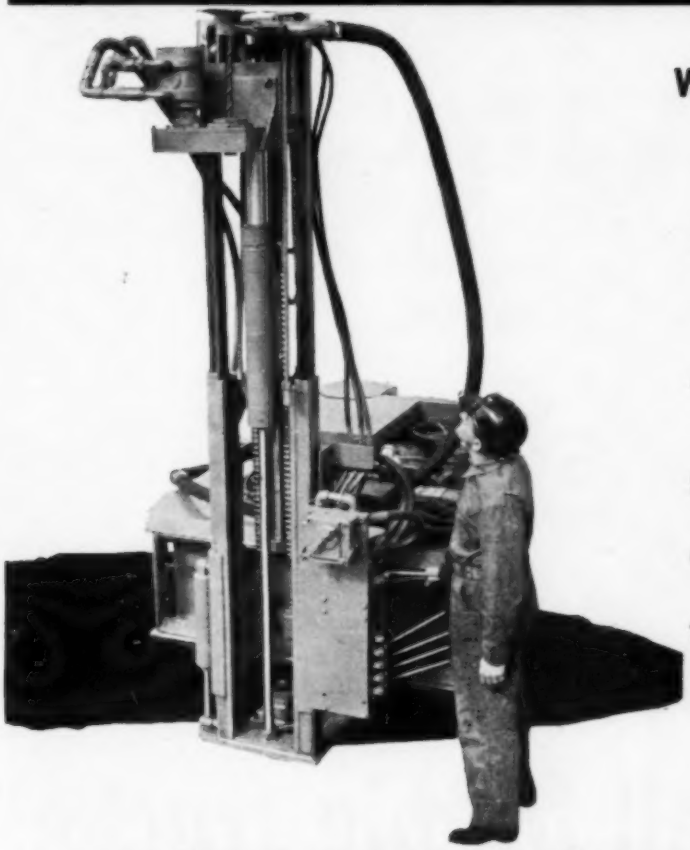
Form BM-100

Presenting the New

FLETCHER MODEL FTR

"FLOOR TO ROOF"

ROOF CONTROL DRILL



With These EXCLUSIVE FEATURES

1. Braces rigidly between floor and roof so drill travels in true straight line.
2. Provides more usable thrust for hardest drilling because of positive column action.
3. Puts drill guide against roof—hydraulically—so bit cannot wander.
4. Combines dust collector head with drill guide—speeding cycle by eliminating separate collector elevation.
5. Gives necessary stability and stroke for very-high-seam operation.
6. Makes installation of bolted crossbars a simple and safe operation.
7. Protects operator—by acting as safety jack at point roof is being disturbed.

THE COAL MINES FAVORITE ROOF DRILL IS FASTER, BETTER THAN EVER

Hundreds of **FLETCHER ROOF CONTROL DRILLS** in mines throughout the country have proven their speed, ruggedness, and dependability. In fact, more mining men—men who have tried them all—standardize on **FLETCHERS** than on any other machine on the market. The new floor-to-roof feed system now offers the additional exclusive advantages listed above.

FLETCHER drills are available in heights from 28 inches to 11 feet with feeds from 24 to 102 inches. They will deliver highest capacity at lowest cost in any mine.

For further information address P. O. Box 353, Huntington, West Va., or phone Huntington 4-4186.

J.H. FLETCHER & CO.

HUNTINGTON, W. VA. CHICAGO, Ill.

Mack Model LRSW hauling off overburden.

big shovels call for big trucks

Today's big-yardage jobs demand maximum loads per haul and faster time cycles from shovel to dumping point and return. Increasing use of larger and larger shovels points to the Mack Models LRSW and LRVSW six-wheel dump trucks as the answer to these stepped-up requirements.

Here are trucks that are built to keep big shovels on the go...to give mine operators increased production per driver and per truck dollar invested.

These Macks will move 21 to 28 yards with unfaltering ease over the toughest terrain. No miring in with these Macks—they have the advantage of Mack's famous Balanced Bogie with exclusive Power-Divider, enabling them to pull through where other trucks bog down. In actual service these models have demonstrated their ability to maintain the time schedule of smaller-capacity dumpers.

Why not investigate the big-unit economy of Mack Models LRSW and LRVSW. It will pay you to see these big jobs at work.

MACK TRUCKS Empire State Building, New York 1, N.Y.

3030

HAUL

HAUL at high capacity.

HAUL the low-cost way.

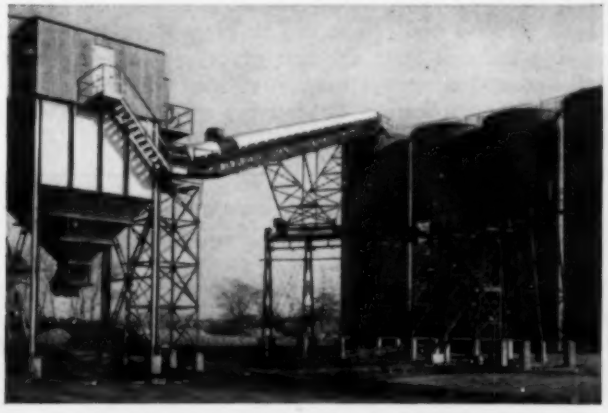
HAUL with less maintenance.

HAUL anywhere—above ground or below ground . . . from mine to classifying plant, to storage, to car, barge or truck.

HAUL with standardized, pre-engineered Barber-Greene Conveyors.

Barber-Greene standardized conveyors permit faster quotation and delivery, lower cost erection, easier future alteration. Pre-engineered components include: Frames, Trusses, Drives, Take-ups, Feeders, Hoppers, Brakes, Housings, Supports, etc. Ask for the Barber-Greene 192-page Conveyor Catalog.

Over 4,300′ of Barber-Greene Belt Conveyors handle 45,000 to 55,000 tons of coal each month at the Sauceda mine in Palau, Mexico. These conveyors move the coal to the transfer bin for loading, to the stacker for stockpiling and reclaiming . . . or to the processing plant.



This 119′ Barber-Greene Stacker pivots on a curved track to deliver up to 250 tons per hour to any of five silos. Built for the Chicago Wilmington & Franklin Coal Company, this Barber-Greene installation has a capacity that can be quadrupled when required.

55-22A-UPE

Barber-Greene

AURORA, ILLINOIS, U.S.A.

BG

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descriptive literature . . . sound movies

cost studies . . . nearby job inspection . . . plant layouts

M-S-A For Increased Production—

ILLUMINATION

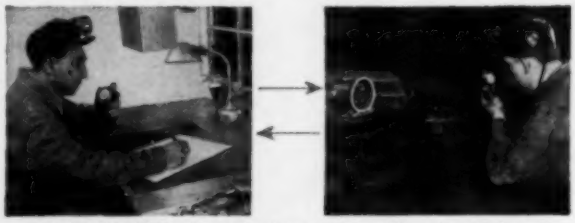
EDISON R-4 ELECTRIC CAP LAMP—Its brilliant, unfailing beam gives miners the light they must have to work mechanized equipment at its greater capacity, safely. Rugged construction equips it for hard underground use, provides dependable service shift-in, shift-out, for years. **EDISON PERMISSIBLE ELECTRIC TRIP LAMP**—Illumination at every angle. Higher wattage provides greater visibility. Cast, ribbed guard protects ruby glass.

Edison R-4 Electric Cap Lamp

Edison Permissible Electric Trip Lamp

COMMUNICATIONS

M-S-A MINEPHONE—Sends dispatcher's orders instantly and simultaneously to all motormen, who can receive and reply while trips are in motion. This clear, two-way voice communication keeps trips moving, minimizes waits on sidings. Repair needs are relayed in seconds. Over-all safety is improved because one message alerts all personnel at once.



M-S-A MinePhone keeps haulage in step with mechanization.

ROCK DUSTING

M-S-A BANTAM 400 ROCK DUST DISTRIBUTOR—This versatile unit discharges 30 lbs. per minute through 400 ft. of hose, or 100 lbs. per minute through 25 ft. of hose. Its low height makes it ideal for low coal application, and for transporting on any belt or pan conveyor with 16-inch clearance. Because of its 400 feet of hose, airways and rooms can be completely dusted without removing the unit from the belt or other haulage equipment. Small size makes storage easy. Also used for fire fighting and wet rock dust application. Other types available for a variety of rock dusting needs.

M-S-A Bantam 400 Rock Dust Distributor

METHANE DETECTION

M-S-A METHANE ALARM—Continuously samples air at working face. Flashing red light warns miners of hazardous concentrations. Automatic; portable; can be mounted. **M-S-A METHANE RECORDER**—Continuously charts methane concentrations in return air. Accurate safety check against unusual gas conditions. Serves as guide for regulating volume of air to maintain proper and economical ventilation standards. Records, and gives visual and audible warnings. **M-S-A—WOLF JUNIOR FLAME SAFETY LAMP**—Dependable, steady flame, guarded by improved ventilation. Easy-to-read graduated chimney. **M-S-A METHANE DETECTOR W-8**—Instant, accurate reading of methane. Ideal for spot checking. Light; portable. **M-S-A METHANE TESTER TYPE E-2**—Pocket sized unit. Indicates methane as low as .2%.

M-S-A Methane Alarm

M-S-A Methane Recorder

M-S-A—Wolf Junior Flame Safety Lamp

M-S-A Methane Detector W-8 M-S-A Methane Tester Type E-2

When you have a safety problem, M-S-A is at your service. Our job is to help you.

MSA
SAFETY EQUIPMENT HEADQUARTERS

Greater Safety—Check Here M-S-A

RESPIRATORY PROTECTION

M-S-A SELF-RESCUER—Emergency breathing protection against carbon monoxide, smoke. Light; comfortable. Individual carrying case or cache assembly for underground storage. **M-S-A DUSTFOE #55 RESPIRATOR**—Light; compact. Approved breathing protection against dusts. Maximum vision. **M-S-A CHEMOX**—Complete breathing protection in any atmosphere. U.S. Bureau of Mines Approved. Generates own oxygen supply from replaceable chemical canister. Light (13½ lbs.). **M-S-A McCAA TWO-HOUR**—Ideal for rescue work, fire fighting. Complete breathing protection for minimum of two hours.


M-S-A Self-Rescuer

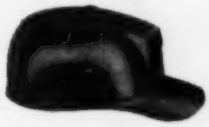

M-S-A Dustfoe #55 Respirator

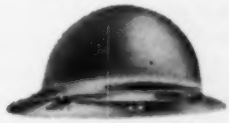

M-S-A Chemox Oxygen Breathing Apparatus


M-S-A McCaa Two-Hour Oxygen Breathing Apparatus

HEAD PROTECTION

M-S-A COMFO CAP—Combines light weight with complete head protection. Low crown design for low coal mining. Well balanced; durable. **M-S-A GLASS FIBER HAT**—High pressure molded for strength; smooth contours deflect falling objects. Available in red, white, yellow, green, blue, gray, black.


M-S-A Comfo Cap


M-S-A Glass Fiber Hat

FIRST AID EQUIPMENT

M-S-A UNIT FIRST AID KITS—Complete assortment of Unit "D" package dressings. Each package wrapped in cellophane. Steel case. **M-S-A EMERGENCY FIRST AID OUTFIT**—For storage at working face. Contents selected to provide aid for practically every mining emergency . . . kits, splints, stretcher, blankets, etc. **M-S-A MINER'S FIRST AID CABINET**—Supplied with medical dressings and equipment for mine hospital or dressing station use.


M-S-A First Aid Kits


M-S-A Emergency First Aid Outfit


M-S-A Miner's First Aid Cabinet

ARTIFICIAL RESPIRATION

M-S-A PNEOLATOR—Completely self-contained artificial respiration device. Supplies oxygen under intermittent positive pressure, automatically. **M-S-A PULMONARY VENTILATOR**—Effective intermittent positive pressure for the treatment of many respiratory disorders. Provides complete respiratory tract distribution of aerosols.


M-S-A Pneolator


M-S-A Pulmonary Ventilator

EAR PROTECTION

M-S-A EARSAVER—Peaked cap assembly for persons exposed continuously to relatively high level noise. **M-S-A NOISEFOE**—Head-set suspension type; easy to put on, take off. For intermittent entry into noisy areas. **M-S-A EAR DEFENDERS**—Insert type. Provide effective closure of ear canal. Three sizes for comfortable, easy fit.


M-S-A Earsaver


M-S-A Noisefoe


M-S-A Ear Defenders

MINE SAFETY APPLIANCES COMPANY
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Every day, M-S-A products are helping mine operators realize greater production, increased safety. Many operators have also found that M-S-A's complete line results in product recommendations that meet exactly the requirements of the job. And M-S-A's complete mining area coverage pays off in efficient, "when you need it" service. We have complete bulletins on each of the items shown above. Or, if you prefer, we will send you our 182-page catalog. Write or call.

The BOWDIL® co.

ORIGINATORS OF THROW-AWAY BITS; MANUFACTURERS OF BARS, BITS, CHAINS AND OTHER PRODUCTS FOR COAL MINING; CUSTOM MACHINERY DESIGNERS AND BUILDERS; HEAT-TREAT SPECIALISTS; SALES AGENTS FOR THE CINCINNATI ELECTRIC DRILL.

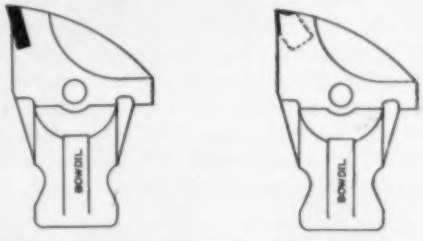
BOWDIL BITS

NEW I-29 CONCAVE

Patented concave design increases bit clearance, assures longer wear without increased power consumption. Made from special steel, rolled, with concave faces. Tests in hundreds of mines have proven these Bits last 15% to 20% longer. Bowdil makes the right size and shape bit for every mining condition, to fit all types of chain.

NEW CARBIDE TIP BITS

No. 1-27N3 No. 1-27N5



Superior in design and construction, with great strength and rigidity in the shank and clamping method.

BOWDIL CUTTER BARS

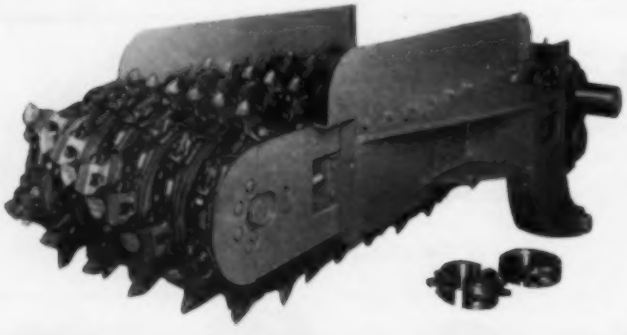
are designed for extra strength and power saving. Rivet-free body, Z bar construction, wide wearing strips make it the sturdiest bar in mining. Bowdil Bars are standardized to fit all mining machines.

PHOTO BY WM. VANDIVERT FOR WEST KENTUCKY COAL COMPANY IN COOPERATION WITH BITUMINOUS COAL INSTITUTE.

FABRI-FORGE CHAIN

Rugged, easy to maintain, the dropforged lug body stands up under heavy wear with breakage practically eliminated. A major improvement is the true-running radial track guide.

NOW AVAILABLE WITH BIT OPENING ½" x 1" (takes all type bits)



NEW 6-IN-ROW RIPPER HEAD

Using 6 renewable independently adjusted Cutterbars, with all 6 Chains similar in kerf and lacing arrangement for interchangeability. All 6 spockets interchangeable. Improved design head drive shaft and sprocket assembly using 2 piece sprockets to maintain extreme tension to the shaft.

These are only a few of the features and advantages in this modern Ripper Head for Continuous Mining. Ask a Bowdil representative or write for more detailed information.

SPROCKETS FOR ALL MINING MACHINES

Bowdil Sprockets are made from special heat-treated alloy steel and designed for hard wear. Our stock of over 100 different styles includes clutch, spline and keyed types—various tooth designs of 4 to 13 teeth.

WANT SOMETHING SPECIAL? BOWDIL CAN BUILD IT

Bowdil has the staff and facilities to work with you on any custom building or rebuilding, engineering, machining, fabricating. Excellent heat-treat equipment. If you have a problem, bring it to Bowdil.

BATTERY OPERATED MINE LOCOMOTIVE DESIGNED AND BUILT BY BOWDIL

SALES ENGINEERS IN—Whitesburg, Kentucky—West Frankfort, Illinois Charleroi, Pennsylvania — Denver, Colorado — Big Stone Gap, Virginia Danville, West Virginia — Canton, Ohio — Birmingham, Alabama Helper, Utah—Kansas City, Missouri—Centerville, Iowa—Topeka, Kansas New Castle, England — Alberta, Canada

The BOWDIL® co.

BOYLAN AVE. S.E. CANTON 7, OHIO

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Duff-Norton Jacks

are safer, sturdier, faster, more economical—meet every modern mining need!

SINGLE ACTION RATCHET LOWERING JACKS WITH FOOT LIFT

514-MT
516-MT
521-MT

5 TONS Furnished with double round sockets and steel operating lever 1" x 30". *When jack is not under load,* head can be dropped or tripped instantly.

1017
1020
1022

10 TONS Furnished with either of the following sockets and operating levers: double round or small single round and steel lever 1¼" x 60"; large round and wooden lever 2⅜" x 48"; or square socket to fit your own lining bar.

1522
1528

15 TONS Double round socket and steel lever bar 1¼" x 60" long are standard equipment. Also furnished with large round socket and wood operating lever 2⅜" x 48" long; or square socket to fit your lining bars.

2028

20 TONS Double round sockets and steel lever 1¼" x 60". Also furnished with small single round socket; large round socket with wooden lever 3⅛" x 66"; or square socket to fit your lining bar.

Jacks can be furnished with either curved or flat tops.

Every Duff-Norton ratchet jack is guaranteed at full capacity for loads applied to either head or foot lift.

Jack No.	514-MT	516-MT	521-MT	1017	1020	1022	1522	1528	2028
Cap. Tons	5	5	5	10	10	10	15	15	20
Ht. Ins.	14	16	21	17¼	20	22	22	28	28
Raise Ins.	7½	9½	14½	9	11½	12	11½	17½	18
Ft. Lift Ht. Ins.	1½	1½	1½	2¼	2¼	2¼	2½	2½	2½
Weight Lbs.	31	34	41	55	59	65	82	96	103

*Duff-Norton Patented spring mechanism, one complete unit—easily replaced.

MINE ROOF JACKS AND FITTING

Factory made complete jacks.
8—16 Tons
MR-8
MR-16

Angle Jack
8—16 Tons

Make-it-yourself fittings.
8—16 Tons
MR-80
MR-160

Pin timbering jacks
8—16 Tons

For pin timbering or angle jacks with square tubing, specify MR-8-P or MR-16-P. For round tubing, specify MR-80-P or MR-160-P.

JACK FITTINGS The following five heads, three handles, and three bases are available in any combination:

HEADS

TYPE "H"—used with 4" H-Beams or rails.

TYPE "B"—ball and socket for flat timbers, beams or direct contact.

TYPE "T"—6½", 8¼", and 11¼" sizes for H-beams, round or square timbers.

TYPE "L"—for angle support of ends of timbers, beams or rails.

TYPE "V"—for various diameter round timbers.

HANDLES

SLIDE HANDLE—for extra leverage in close quarters.

DROP HANDLE—similar to the slide handle except it folds down when not in use.

WING NUT HANDLE—for open areas where a firm, two-handed grip is possible.

BASES

ROUND BASE—cored pocket to fit on standard or extra strong pipe, with ⅞" diameter hole to fasten fitting to pipe. Use with ¾" diameter bolt.

ROUND FISHTAIL BASE—cored pocket to fit standard or extra strong pipe, with ⅞" diameter hole to fasten fitting to pipe. Use ⅜" diameter bolt. End grooved to fit over 1½" diameter pin.

SQUARE FISHTAIL BASE—cored pocket to fit over end of square tubing, with ⅞" diameter hole to fasten fitting to pipe. Use with ⅜" diameter bolt. End is grooved to fit over 1½" diameter pin.

MR-8 or MR-8-P (Capacity 8 tons)
MR-16 or MR-16-P (Capacity 16 tons)

Minimum Height Closed	Maximum Height Open	MR-8 Weight Pounds	MR-16 Weight Pounds
30"	45"	31	45
36"	51"	33	48
42"	57"	34	51
48"	63"	36	54
54"	69"	38	56
60"	75"	40	59
66"	81"	42	62
72"	87"	43	65

PIPE NOT FURNISHED

Jack No.	Capacity Tons	Screw Dia Inches	Screw Raise Inches	Pipe Column to be used
MR-80 or MR-80-P	8	1½	15	2" Standard
MR-160 or MR-160-P	16	1¾	15	2" Extra Strength

Heights given are for type "B" heads. For other heads deduct 2" on MR-8 models, 1½" on MR-16 models. MR-8 screws are 1½" diameter. MR-16 screws 1¾" diameter.

Write for Bulletin AD10—

"A Handy Guide for Selecting Mine Jacks."

Duff-Norton Company

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

the high-profit cleaning process for maximum tonnage of shipping-grade coal

HERE ARE THE REASONS WHY

HMS accurately separates coal from bone on a gravity difference as low as 0.01, regardless of fluctuations in the refuse-content of the raw feed.

HMS duplicates the washability curve of your coal at any gravity you select from 1.25 to 2.50.

HMS handles a full size-range from 3/32″ to 8″.

HMS requires far less medium make-up than dense-media plants not using the patented HMS medium-recovery and re-conditioning principle.

IN A NUTSHELL

HMS earns a handsome net profit after plant amortization, operating expenses and nominal royalty payments.

American Cyanamid Company is the sole, world-wide technical and sales representative for patented Heavy-Media Separation Processes owned or controlled by American Zinc, Lead and Smelting Company. We will be pleased to give you the benefit of our long experience with these processes and to negotiate a license for their use at realistic royalty rates on behalf of the licensor.

AMERICAN *Cyanamid* COMPANY

MINERAL DRESSING DEPARTMENT

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Kleenslot

WEDGE WIRE PREPARATION SCREENS

mining

foods

chemicals

abrasives

oil

FOR DEWATERING, SCREENING, WASHING, EXTRACTING, FILTERING or SIZING APPLICATIONS

SCREEN GUARDS

A new innovation in the mining and industrial field. Particularly adaptable for use in flumes. The screen guard is built right into the screen and the vertical guard bars keep the larger lumps of material above the guard bars, permitting only the finer particles to pass over the screen. Special sizes can be furnished.

VIBRATOR SCREENS

They can be designed and adapted to fit any make of vibrator. You do not have to change your present machine to accommodate this screen. It is of quality construction and built to give maximum service. The rigid construction and method of installation prevents "whipping".

MARCEL-TYPE SCREENS

This screen is entirely different inasmuch as it is of a Marcel-type construction. It was designed for operations where slivers passing through are objectionable in the end product. This screen can be made in all sizes and shapes wherever applicable to higher and productive efficiencies. It gives long life and non-blinding operation.

ALUMINUM SCREENS

This aluminum screen has all of the attractive and sturdy features of many other metals. In addition, it offers flexing action that adds capacity and dewatering abilities which are almost unbelievable. No changes are necessary in the body of the screen to effect its installation.

NON-BLINDING — NON-CLOGGING - LONGER LIFE - MOST ECONOMICAL

The diagram at left shows all of the efficiency that can be furnished to you by KLEENSLOT Wedge Wire Preparation Screens, inasmuch as the wedge construction permits easy clearing. KLEENSLOT Wedge Wire Screens can be furnished in practically any type of metal. It costs nothing to obtain a Wedge Wire recommendation free of charge. Complete literature is available for the mining, oil, food, chemical and abrasives industry. There is a KLEENSLOT Wedge Wire Screen for every application.

★

WEDGE-WIRE CORPORATION

GAS STREET AND NICKEL PLATE R. R.
WELLINGTON, OHIO

FACING A TOUGH PROPOSITION?

you can beat it with *JALLOY*

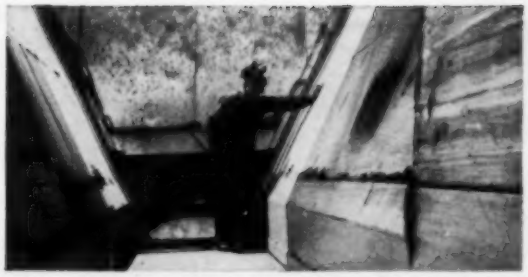
Only a seasoned hunter with the right equipment can stand up to a charging rhino. And, likewise, only a special steel like JALLOY can withstand severe impact and abrasion . . . day after day. In comparison with mild steels as well as other abrasion-resistant steels, JALLOY gives outstanding results when heat-treated to your specifications.

This modern heat-treated plate brings savings in steel costs, maintenance, and repair, and also is easily welded. JALLOY is available in three grades, each of which is designed for specific applications.

J&L STEEL

Complete data concerning CHEMICAL COMPOSITION . . . HEAT TREATMENT . . . WELDABILITY . . . PHYSICAL PROPERTIES . . . will be mailed to you promptly. Write today.

Jones & Laughlin
STEEL CORPORATION — *Pittsburgh*



Jalloy Plates outlast other steels by margins of 4 to 1

Jalloy lowers maintenance costs on ore and coal conveyors

Jalloy provides longer wear with less repair in truck bodies

Jalloy Aprons in Tyrock screen last 3 times as long as other steels

Jalloy heat-treated steel plate beats wear due to impact and abrasion

Jones & Laughlin Steel Corporation
3 Gateway Center, Dept. 411, Pittsburgh 30, Pa.

☐ Please mail complete data concerning Jalloy.
☐ Please have your representative call.

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

GraybaR...

A complete electrical supply service for mining and refining

Electrical equipment and supplies to meet the special needs of the mining industry are an important part of Graybar's all-inclusive service. Located at or near leading mining centers, Graybar offices and warehouses serve as prompt local supply sources for the products of over 300 leading manufacturers. Graybar Representatives in these areas are well informed on underground or above-ground service requirements. Specialists on wiring, lighting, communication, and power apparatus are ready to help you. 430

ELECTRIC CABLE

GRAYBAR offers a complete line of wire and cable for power distribution, for mining machinery and locomotives, shot firing, signaling, and other specialized needs.

Simplex mining machine cable has tough outer selenium-neoprene armor to stand up in mining service.

Tirex shot-firing cable combines flexibility and light weight with high strength.

MOTORS, CONTROLS, FANS

General Electric motors and controls, meeting Bureau of Mines or Underwriters Laboratories requirements for hazardous areas, are available via GRAYBAR as a part of our power apparatus service. Ilg ventilating fans and blowers of all types are also available for mine use.

MINE TELEPHONES

U.S.I. Mine Telephones are sound-powered . . . require no batteries or external power supply. They transmit speech clearly over lines of any length. Supplied for either code or selective signaling up to 24 stations. U.S.I. Mine Telephones carry Bureau of Mines Approval No. 905.

TAPE AND WIRING SUPPLIES

GRAYBAR "Victor" tape is a widely used favorite. Weatherproof sockets, fuses, circuit breakers, panel boards, switches, and terminals are among the many additional wiring supplies distributed by Graybar for electrical systems above ground or below.

LIGHTING EQUIPMENT

Lamps and lighting equipment offered via GRAYBAR include explosion-proof, vaporproof and other specially protected types. Also a full line of floodlights for outdoor service, fluorescents for offices and drafting rooms. Our portables and flashlights are listed by Underwriters Laboratories for Class I, Group D conditions.

Graybar offices and warehouses are located in over 120 principal cities — there's sure to be one near you!

CALL GRAYBAR FIRST FOR...

GraybaR Everything Electrical

GraybaR **ELECTRIC CO., INC.**
430 Lexington Avenue, New York 17, N. Y.

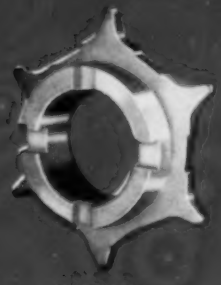
IN OVER 120 PRINCIPAL CITIES

take a good look at these

TSP

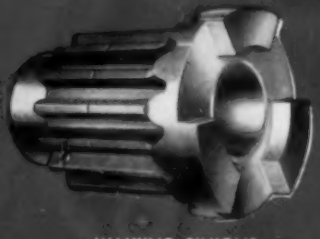
products for the mining industry

BEVEL GEARS & PINIONS



SPROCKETS

SHEAVE WHEELS & PINS



WALKING PINIONS

CAB ROLLERS

CAT DRIVE CLUTCHES

CONVEYOR ROLLERS

VERTICAL SWING GEARS

SPUR GEARS & SHAFT PINIONS

ROTATING SHAFTS

SHIPPER SHAFTS & PINIONS

There are thousands of "Tool Steel Process" products in hundreds of applications in the Mining Industry. They're guaranteed to deliver longer life in the same service than any other competitive product.

Here's Why: TSP products are hardened by our special process. The file hard surface to the full depth of permissible wear gives maximum wear. The core, refined for toughness and ductility gives maximum strength.

Enjoy the tremendous savings in operating and maintenance costs you receive from guaranteed "Tool Steel Process" products.

The Standard of Quality Since 1909

HOIST GEAR & PINION
SPLINED PINION & SPIDER

THE TOOL STEEL GEAR AND PINION CO.

CINCINNATI 16, OHIO, U. S. A.

THIS IS IT!

The revolutionary NEW three-way

DRILLMASTER

...the only completely self-contained, self-powered drilling rig that combines these three advanced rock drilling methods

HERE in one completely integrated package is a totally new "three-way" rock drilling machine designed to speed up work and provide a range of hole sizes and drilling depths heretofore not available in a blast hole drill. The versatile Ingersoll-Rand Drillmaster embodies three combinations or methods of drilling.

Combination one utilizes the new revolutionary DEPTH-MASTER or "down the hole" drill for deep blast holes up to 6" in diameter.

Combination two is available with the POWER-MASTER a new heavy-duty hammer drill for 4¼" holes.

Combination three with the ROTO-MASTER rotary drill is ideal for rotary drilling for hole sizes up to 6¼". You can buy any one or all three of the drilling combinations to suit your own requirements.

Never before has there been a rock drilling machine that offered so much for blast hole drillers. The Drillmaster's versatility (three ways of drilling), its independent rotation, and long wearing Ingersoll-Rand Carset Bits will give you faster and cheaper drilling in any kind of rock.

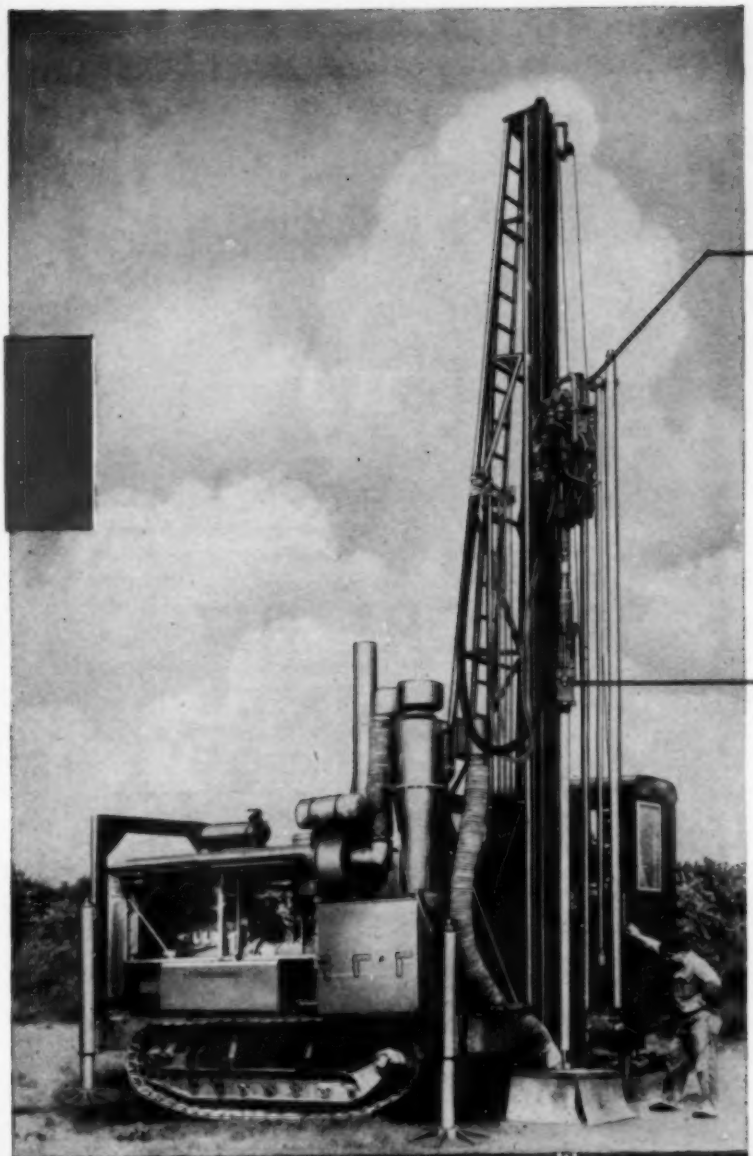
Whatever your rock drilling problem, consult your Ingersoll-Rand representative. His experience is yours for the asking. Ask him or write direct for informative Drillmaster Bulletin, Form 4164.

This new eight page informative booklet will give you the complete Drillmaster story. Ask your I-R representative for a copy or write for Bulletin 4164.

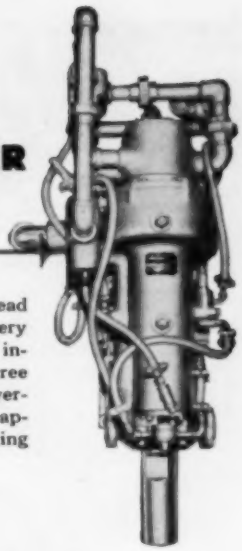
Ingersoll-Rand

8-184 11 Broadway, New York 4, N. Y.

ROCK DRILLS • COMPRESSORS • PUMPS • AIR TOOLS • OIL & GAS ENGINES • CONDENSERS



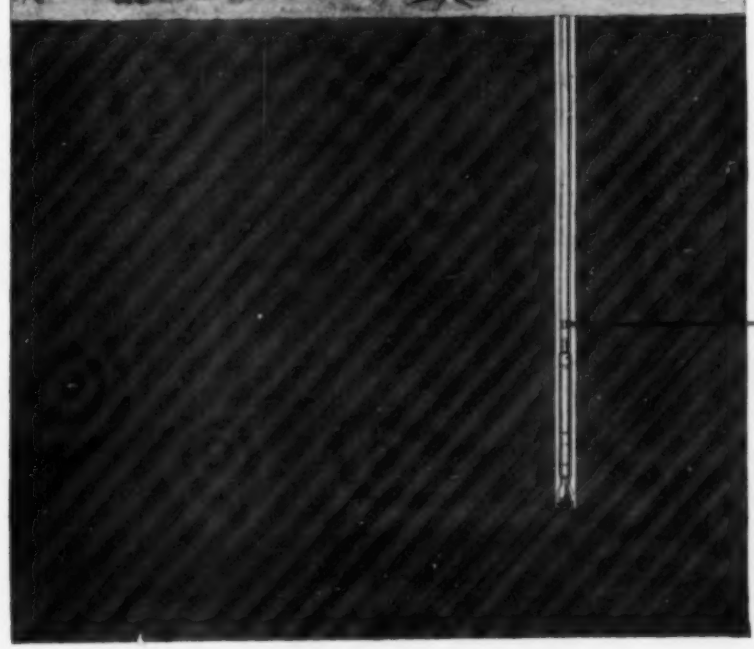
ROTO-MASTER
"rotary drill"



This powerful rotary drill head is standard equipment on every Drillmaster and supplies the independent rotation for all three methods of drilling. This powerful independent rotation is appreciated by all when drilling tight or broken ground.

POWER-MASTER
"out-of-the-hole drill"

The Power-Master, a new extra heavy-duty hammer drill is the most powerful machine in its class. It provides the fastest drilling combination for 4¼" holes to 60 ft. in depth, making it second to none for construction work. It utilizes long wearing Carset Bits on proven Ingersoll-Rand rods and threads.



DEPTH-MASTER
"down-the-hole drill"

In this truly outstanding contribution to rock drilling the drill actually goes down the hole with the bit — No energy is lost in long heavy drill steels and much deeper blast holes are possible than with hammer drills. Rotation is provided by the Roto-Master and 6¼" Carset Bits are used.

11-RU Universal Cutter, courtesy Joy Manufacturing Co.

MORE BITS in the LINE...

A BETTER FIT in the MINE!

★ 22 Different Styles of Cutter Bits
★ 2 Styles of Finger Bits
★ 2 Styles of Roof Bolting Bits
★ 3 Styles of Coal Drill Bits

The unequalled range of selection that is available to you in Carmet carbide-tipped coal cutter and drill bits simply means this: that you can match up your bits just that much more closely with the actual conditions you have!

And *that* means you can profit by the greatest increase in cutting speed and tons cut per bit setting—the greatest reduction in down time and in over-all bit cost per ton—that is possible for you to secure *anywhere* with carbide bits. What's more, you have added assurance of top efficiency in the overlaying cap of steel that *double-bonds* the carbide tip of each Carmet cutter bit firmly in its seat. That's a feature which Carmet *originated*. It operates to protect you against tip loss, and to permit cutting on both sides as well as in front—eliminating side drag, reducing power consumption, etc.

Even the shank steel in Carmet carbide bits is a product of quality control: tough enough to insure against bending or breakage, yet of a hardness to permit set screw locking. ● Just *try* Carmet bits—see for yourself what they'll do! We'll be glad to cooperate with you in proving their advantages in your operation . . . see your distributor (left) about a test order. ***Allegheny Ludlum Steel Corporation, Carmet Division, Detroit 20, Mich.***

CARMET DISTRIBUTORS

Persinger Supply Co., Williamson, W.Va.
Persingers, Inc., Charleston, W. Va.
Leechburg Supply Co., Leechburg, Pa.
Oglebay Norton Co., Cleveland, Ohio
Drillmaster Mfg. & Supply Co., Evansville, Ind.
Crandall Engineering Co., Birmingham, Ala.
Carbon Transfer & Supply Co., Helper, Utah
Johnson Supply Co., Denver, Colorado

Write for your copy

This informative 16-page booklet gives complete data, sizes, etc. on all styles of Carmet carbide-tipped cutter and drill bits. Also included is a valuable methods manual on reconditioning methods and equipment. Gladly sent free on request.

ADDRESS DEPT. CA-691

The Original DOUBLE-BONDED Carbide Bit

CARMET® AL

W&D 5412B

GM DIESEL
CASE HISTORY No. 1A3-16

OWNER: Crowe Coal Company, Kansas City, Mo.

INSTALLATION: Six GM Diesel-powered Dart trucks . . . three 20-ton rear-dumps and three 40-ton bottom-dumps. GM Diesel-powered Bucyrus-Erie #38-B shovel with 2¼-yard bucket. The company also operates three 20-ton bottom-dumps powered with 4-cycle Diesels.

PERFORMANCE: GM Diesel-powered trucks have faster pickup, respond to throttle controls better, use less lube oil. Engines take less time—cost less to overhaul. Shovel strips 1000-1200 tons of coal in 7¼ hours—burns 4 gallons of fuel per hour.

Quicker Pickup-Faster Hauling

MISSOURI's Crowe Coal Company operates nine trucks—six powered by General Motors 2-cycle Diesels and three with 4-cycle Diesels. They report the GM Diesel-powered trucks "respond quicker, use less lube oil, are easy to overhaul."

A General Motors Diesel does "respond quicker." It gets more work done than most engines, partially because of its 2-cycle "power on every piston downstroke" design. It costs less to buy. It costs less to maintain because GM Diesel replacement parts cost less (valves up to 62% less and cylinder liners up to 40% less) than parts for comparable Diesels.

Today you can get GM Diesel power in more than 750 different models of equipment built by over 150 manufacturers. Call in your local GM Diesel distributor or write direct for more information.

It Pays to Standardize on

GM
GENERAL MOTORS
DIESEL POWER

DETROIT DIESEL ENGINE DIVISION
GENERAL MOTORS • DETROIT 28, MICHIGAN
Single Engines . . . 30 to 300 H. P. Multiple Units . . . Up to 893 H. P.

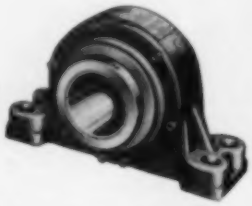
TAPER-LOCK SOLID STEEL CONVEYOR PULLEY

1. *DRUM DESIGN*
—maximum strength
—minimum weight

2. *FULLY ENCLOSED*
no dust—no dirt—no water

3. *SUBMERGED-ARC PROCESS*
—full strength in all welds

4. *TAPER-LOCK BUSHING*
—no walking on shaft
—easy on—easy off!

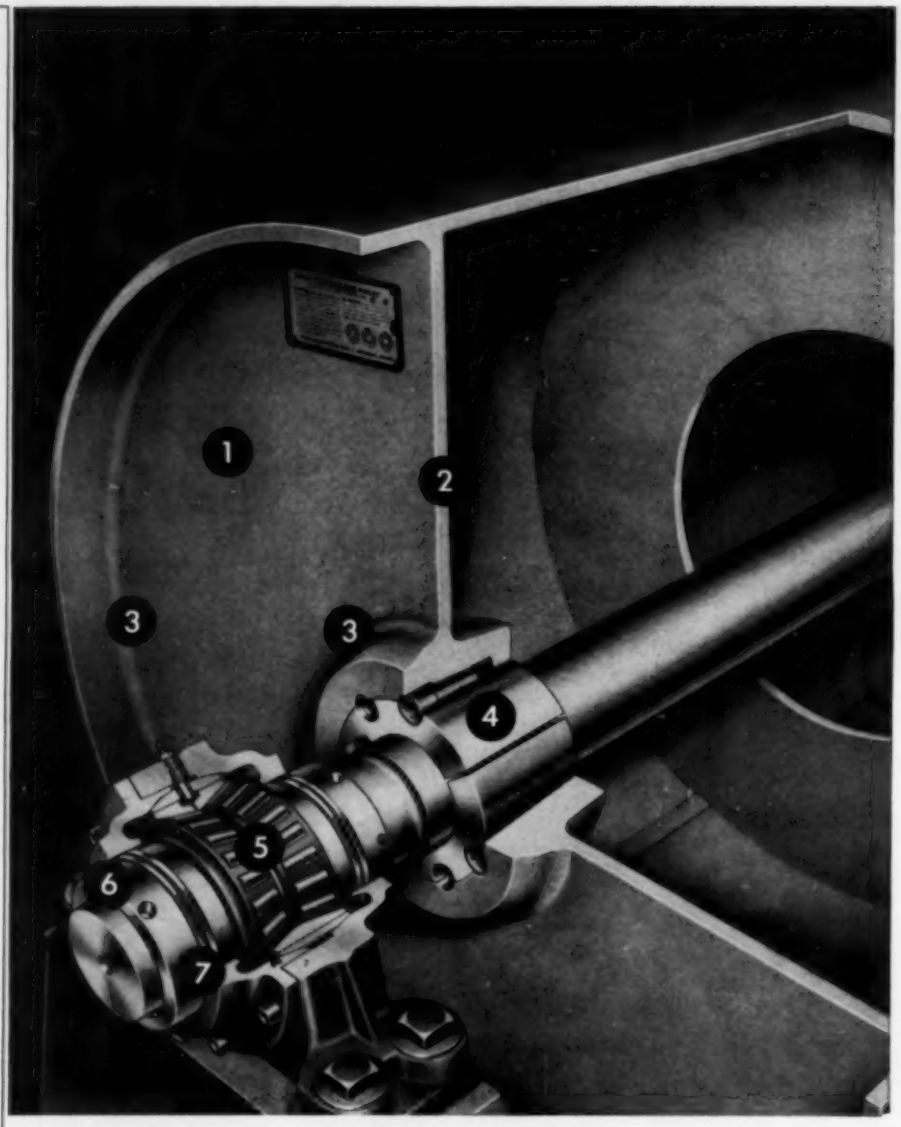


DODGE-TIMKEN ALL-STEEL PILLOW BLOCK

5. *NEW HEAVY-DUTY TIMKEN ROLLER BEARINGS*
—fully self-aligning

6. *HEAVY-DUTY ADAPTER MOUNTING*

7. *Sealed both on and off the shaft with DOUBLE PISTON RINGS*



Here's a heavy-duty combination for tough conveyor jobs!

Pulleys from 6 in. to 8 ft. in diameter, all face widths. Bearings from 2 1⅞" to 10" bores. Popular sizes stocked by our Distributors. Write for detailed information.

DODGE

of Mishawaka, Ind.

Call the Transmissioneer, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.

DODGE MANUFACTURING CORPORATION, 3000 UNION STREET, MISHAWAKA, INDIANA

CINCINNATI...
COAL CUTTING EQUIPMENT

FOR USE ON ALL TYPES OF MACHINES

Each mining operator has his preference for certain mining machines, but regardless of the type of machine or the cutting problem, CINCINNATI has the chains, bits and bars that will give you top efficiency. CINCINNATI has specialized in the design, manufacture and perfection of Coal Cutting Equipment for more than a quarter century. In addition, CINCINNATI is headed by men who have devoted their lives to improved coal cutting equipment . . . to keeping ahead of the field at all times. Today, CINCINNATI MINE is not only manufacturing chains that out-perform and outlast any other chains available for every type of CONTINUOUS MINING MACHINE now on the market, but have developed NEW CHAINS especially adapted for SPECIAL CONTINUOUS MINING MACHINES not yet generally known to the field. Our constant endeavor is to provide the industry with the most improved equipment at all times. Our representatives and our engineering staff are always at your service.

REPRESENTATIVES AT YOUR SERVICE

FRANK ARMSTRONG
Kenilworth, Utah

CARLSBAD SUPPLY CO.
Carlsbad, New Mexico

GORMAN'S LIMITED
Drumheller, Alberta; Edmonton, Alberta, Canada.

W. M. HALES CO.
Chicago, Ill.; Danville, Ill.; Hillsboro, Ill.; Benton, Ill.; West Frankfort, Ill.; Madisonville, Ky.

HUNTINGTON SUPPLY & EQUIPMENT CO.
Huntington, W. Va.

F. G. LICENCE(PTY) LTD.
Durban, South Africa

LYONS MACHINERY CO.
Little Rock, Ark.

McCOMB SUPPLY CO.
Harlan, Ky.; Jellico, Tenn.

PENN MACHINE CO.
Johnstown, Pa.; Pittsburgh, Pa.

SOCIEDAD IMPORTADORA DEL PACIFICO LTDA.
Santiago, Chile.

E. S. STEPHENSON & CO. LTD.
Halifax, N. S., Canada; St. John, N. B., Canada.

J. T. SUDDUTH & CO. INC.
Birmingham, Ala.

UNION SUPPLY CO.
Denver, Colo.

the CINCINNATI MINE MACHINERY CO.
CINCINNATI 25, OHIO

New... BELKNAP

COAL WASHING SYSTEM

"A Packaged Plant"

FUEL PROCESS COMPANY

An ideal unit for small and medium-sized companies looking for these primary essentials – basic structure – prescreening and sizing – duplex washing – closed system solution recovery – sludge recovery – storage and salvage tanks. You get them all in a BELKNAP "Packaged Plant" engineered and designed to fit your specific operation.

Investigate These Advantages

1. Costs Less to Buy—Fewer auxiliary units are required, therefore, the System costs less.
2. Uses Less Medium—Medium consumption averaged as low as 1¢ per ton of coal washed for a full year operating period.
3. Uses Less Water—Water consumption averaged 1½ gallons per ton of coal washed over a full year period.
4. Exceptionally Low Maintenance Cost—Cost records for a five-year period show average of less than ½¢ per ton maintenance costs. Power cost is exceptionally low.
5. No Stream Pollution—The New Belknap Coal Washing System meets all existing specifications regarding anti-stream pollution.
6. No Sludge Disposal Problem—Sludge is collected in the System and disposed of as cleaned fines.
7. Low Operating Cost—The Automatic Specific Gravity & Level Control makes necessary a minimum of supervision to maintain maximum cleaning efficiency.

The New Belknap Coal Washing System has been developed and proved during the last three years in new plants in West Virginia, Virginia, Pennsylvania and Indiana . . . The BELKNAP SYSTEM is available in capacities from 40 tons to 250 tons per hour and size ranges as wide as 7" x 3/8" (1/4" on special applications).

Write for full descriptive bulletin

FUEL PROCESS COMPANY

"D" at 10th AVE.··· SOUTH CHARLESTON··· WEST VIRGINIA

THE ONLY COMPLETE LINE OF MINE HAULAGE EQUIPMENT —RUBBER-TIRE AND TRACK MACHINES FOR EVERY PURPOSE

MODEL 444-D

New version of our well-known Model 444 4-wheel-drive 4-wheel-steer tractor, with improved drive line, steering and brakes. High drawbar pull makes it ideal for larger-tonnage mines with bad bottom. Short turning radius. Length 10′ 6″, width 64″, height 24″, weight 4000#. Disc brakes, gear motor drive. Battery in two quick-change steel trays.

MODEL 444-E

Largest, most powerful tractor available, 4-wheel-drive, 4-wheel-steer. Ideal mainline tram for any smaller mine with long hauls, steep grades, low top. For conveyor mines, the best machine for hauling men and materials. Length 12′, width 74″, height 24″, weight 8000#. Enclosed gear motor drive, contactor control. Long-life battery in two quick change trays.

MODEL PC-8

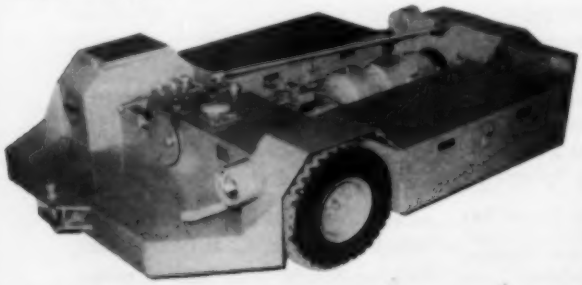
A new addition to our line of utility vehicles, The PC-8 with enclosed gear motor drive and 12 K.W.Hr. battery is ideal for men and materials. The rear cargo deck will accommodate a stretcher, mechanics tools, greasing equipment or drilling equipment up to 2000 pounds capacity. The PC-8 can also double as a Tractor for towing supply trailers. Length 13′ 8″, width 72″, height 24″, weight 4000#.

MODEL MT-6

This battery or cable operated Machine Truck is ideal for hauling cutting machines or other heavy equipment in low coal. Height 24″, capacity 4-tons, bed size 60 inches by 96 inches.

● ● ● ● ●

MODEL HD-8



The HD-8 three-wheel Tractor is a completely new design with fully enclosed drive—no chains or sprockets. The HD-8 is particularly suited for pulling coal cars in truck mines or as a medium duty supply Tractor. Length 10′ 6″ width 72″, height 22″, weight 3700 pounds.

Other KERSEY Products

- Automatic Selenium Battery Chargers
- Rubber Tired Coal and Supply Cars
- Custom Built Battery Rail Locomotives

KERSEY MANUFACTURING CO., INC.

P. O. BOX 151, BLUEFIELD, VIRGINIA PHONE 4228

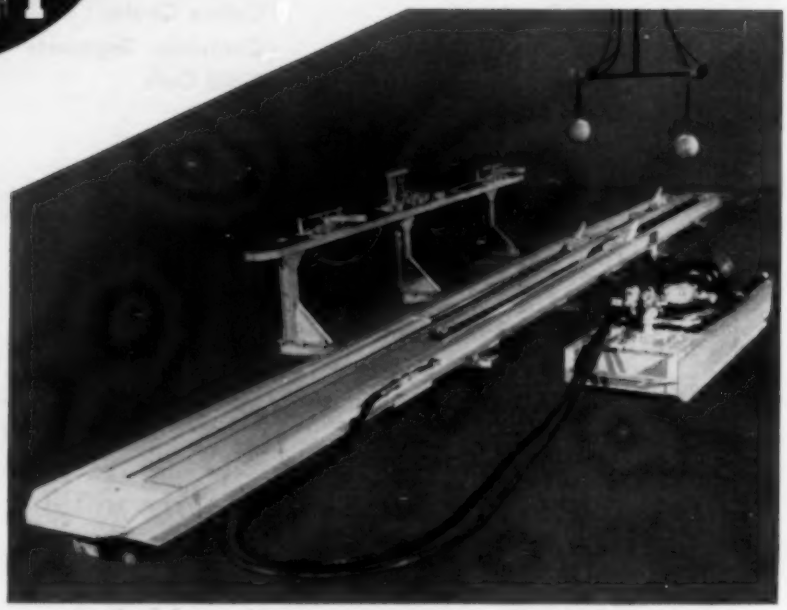
STAMLER
LOADING POINT EQUIPMENT

★ HYDRAULIC

★ AUTOMATIC

★ TESTED

★ PROVEN



Repeat Orders from Most Progressive, Cost Conscious Companies Prove Stamler Superiority!

The STAMLER All-Hydraulic AUTOMATIC LOADING STATION is the only successfully manufactured time-proven production item of its type! In combination with the STAMLER Hydraulic Barney CAR SPOTTER — it will perform *completely unattended* all operations necessary for maximum loading of your cars *uniformly* and without spillage. *And Stamler Equipment is all-hydraulic which means almost complete freedom from failure due to faulty contacts or from coal dust and moisture . . . and almost no maintenance cost!*

Stamler Equipment appeals to the experts . . . those smart mining men who know how to get the coal out of the ground most efficiently at least cost. These men know machinery and they show their preference for Stamler with constant repeat orders. Yes, where we sell one, we're pretty sure to sell more because, once tried, Stamler superiority sells itself. *Why don't you investigate . . . then put Stamler's time and labor saving qualities to work making money for you?*

The STAMLER
Heavy Duty
CAR SPOTTER

•

The STAMLER
Automatic
LOADING STATION

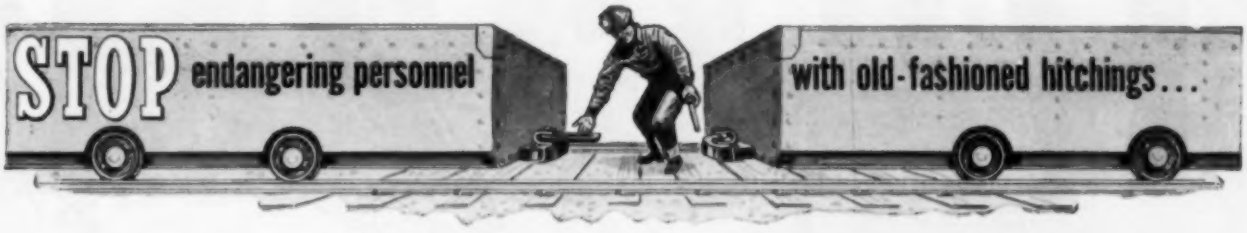
•

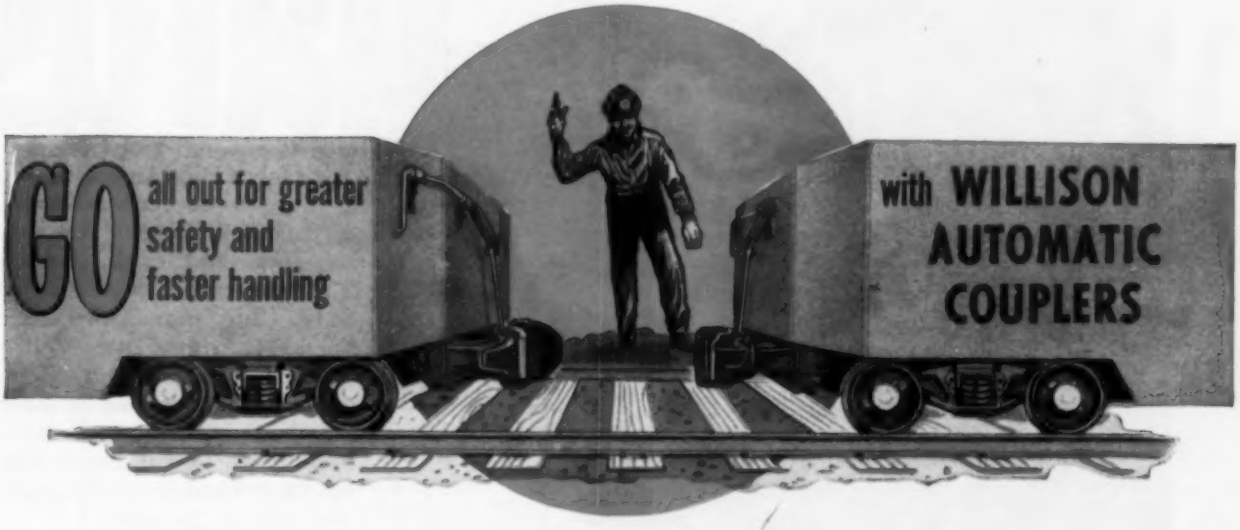
The STAMLER
"Shortie"
CAR SPOTTER

W. R. STAMLER CORP. PARIS KENTUCKY

SCHROEDER BROS., *Exclusive Eastern Sales Agent*, PITTSBURGH, PA.

UNION INDUSTRIAL CORP., CARLSBAD, NEW MEXICO • SALMON & CO., BIRMINGHAM, ALA.





With Willison Automatic Couplers there's no need for personnel to go between cars to couple or uncouple. That means safety—and faster handling because Willisons uncouple from either side. All Willisons couple with each other automatically—there's no matching of coupler heads.

For safety, faster handling and larger tonnages—Willison Automatic Couplers and National Multi-Pad Rubber Draft Gears.

A-9101

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY

Cleveland 6, Ohio

WILLISON AUTOMATIC COUPLERS • RUBBER & FRICTION DRAFT GEARS • NC-1 CAR TRUCKS
NACO STEEL WHEELS • NACO STEEL LINKS & SWIVEL HITCHINGS

17,435,250 yards

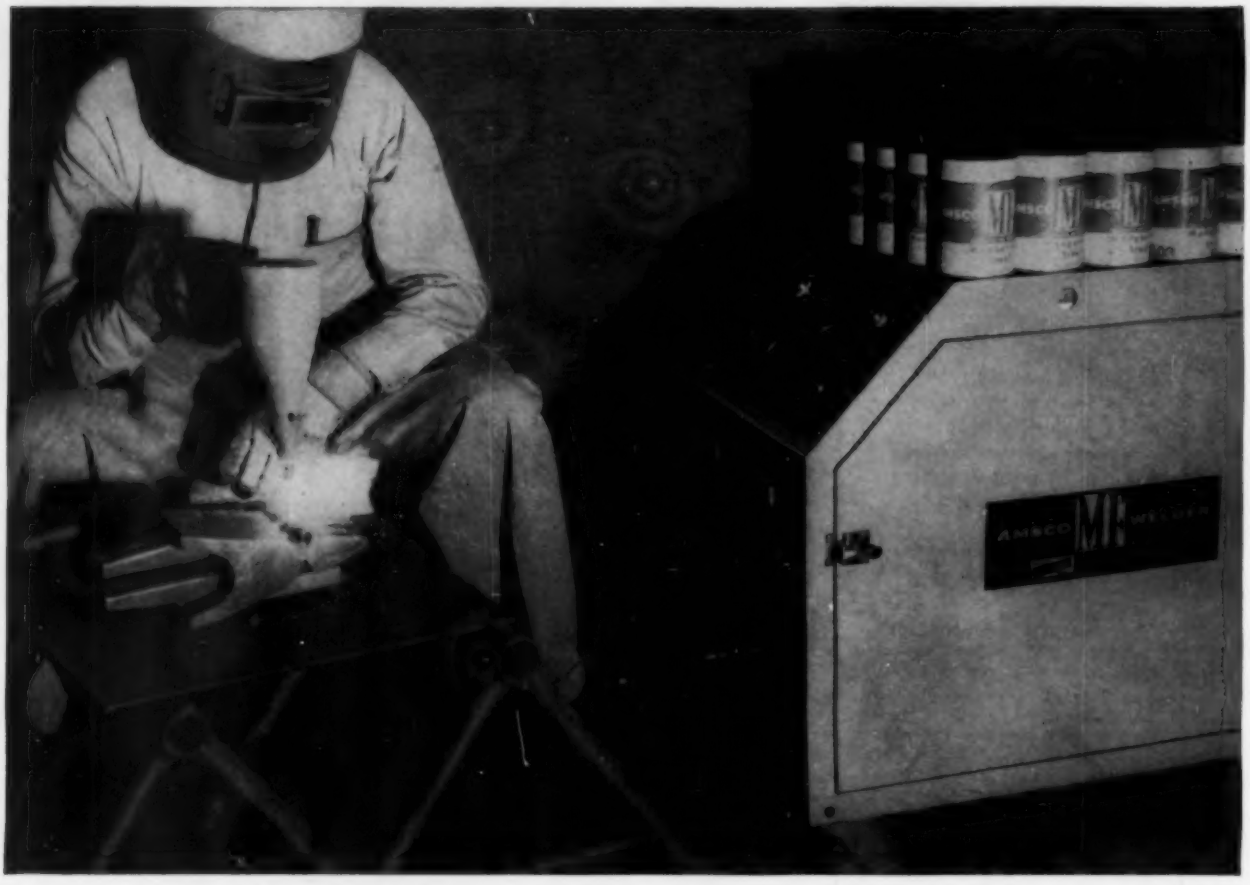
Only 4 Page Automatic Buckets needed to excavate this enormous yardage of slate, blasted rock, and earth overburden. The Peterson Coal Company, Deerfield, Ohio, moved this material since 1942 with a Page Model 618 Walking Dragline and 5 cu. yd. buckets. The two buckets shown in the photo, and one other, are worn beyond economical repair but the Model 618 and the bucket on it are still in good condition.

"That's what we call good service," says Mr. Clyde Peterson, "so when we needed more coal than the 618 could uncover, we bought the Model 721 Page Walker shown in the picture. With a 7 cu. yd. bucket and 125 foot boom it's just what we wanted. Fast, economical, and easy to operate; and the new Page horizontal V-6 Diesel engine has plenty of power for even the heaviest load."

Page Automatic Buckets are noted for their digging ability. Write for bulletin GPB454 for details.

AUTOMATIC DRAGLINE BUCKETS
DIESEL & ELECTRIC WALKING DRAGLINES

Page
ENGINEERING CO.
Clearing P.O. Chicago 38



Welder is shown welding a "wear-sharp" repointer to the shank of a dipper tooth using the Amsco MF and flux.

HARDFACE WITH THE AMSCO® MF

for manual flexibility . . . plus machine speed and accuracy

The Amsco MF combines the visibility and craftsmanship of hand welding with the automatic advantages of machine work. Speed of hardfacing increases because the Amsco MF uses small-diameter electrode and high-current densities which allow the operator to maintain a high deposit rate. The electrode feed is continuous—and automatically regulated—to maintain a constant arc. Thus, the machine automatically *compensates* for operator movement or an irregular welding surface.

Cost of deposited metal is less! The Amsco MF uses coiled, bare mild steel electrode. It feeds through the flux hopper (the cone). There it is magnetically coated with your choice of manganese steel build-up or hardfacing alloy which is carried in the flux. You coat your electrode as you weld at considerable savings in deposit cost.

The machine is portable. It plugs into any standard welding unit, and requires no special setup. See a demonstration of the Amsco MF's speed, quality of weld and uniform deposit. Try it yourself and discover how easy it is to operate. Your Amsco Distributor is ready to show it to you now. Welding products are distributed in Canada by Canadian Liquid Air Co., Ltd.

make your Amsco Distributor HARDFACING HEADQUARTERS

AMERICAN Brake Shoe COMPANY

AMERICAN MANGANESE STEEL DIVISION
Chicago Heights, Ill.

How to keep informed on the "with what" part of your business

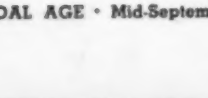
AT YOUR FINGER TIPS, issue after issue, is one of your richest veins of job information—advertising. You might call it the "with what" type—which dovetails the "how" of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better—save your company money.

Each advertiser is obviously doing his level best to give you helpful information. By showing, through the advertising pages, how his product or service can benefit *you* and *your* company, he is taking *his* most efficient way toward a sale.

Add up all the advertisers and you've got a gold mine of current, on-the-job information. Yours for the reading are a wealth of data and facts on the very latest in products, services, tools . . . product developments, materials, processes, methods.

You, too, have a big stake in the advertising pages. Read them regularly, carefully to keep job-informed on the "with what" part of your business.

McGRAW-HILL PUBLICATIONS



PRESIDENT HEARS ABOUT A GRIT-PROOF LUBRICATION SYSTEM

"Farval cuts repairs 100%—saves 31,500 hours"

The Problem: "Expensive bearing failures were crippling our coal cleaning plant. Three men with grease guns couldn't keep coal dust from getting into and ruining bearings. Constant shutdowns to replace bearings seriously interfered with production."

The Solution: "We installed 2 Farval automatic systems of centralized lubrication. Farval immediately stopped shutdowns due to faulty lubrication. That was 1948. Not a bearing lost since!"

The Savings: "Looking after Farval takes only 3 hours a day, saving the equivalent of 2½ men's time. In five years, we're 31,500 man hours ahead. We've extended Farval lubrication to all our machines."

This example indicates the tremendous savings possible with Farval—in repairs, production time, man hours, lubricant! Why not write for our Free Lubrication Survey to learn how Farval can help you?

WRITE for:

Free Lubrication Survey

Without obligation, we will send one of our lubrication engineers to inspect your plant equipment and present a written analysis of what Farval can do for you.

Bulletin 26

Illustrated 20-page book tells the full story of Farval, how it works and how it can save you money.

FARVAL is the Dualine system of centralized lubrication that hydraulically delivers oil or grease, exactly measured, to each individual bearing as often as desired. You'll recognize Farval by the familiar valve manifolds, dual lubricant lines and central pumping station.

THE FARVAL CORPORATION

3260 East 80th St., Cleveland 4, Ohio

Farval is an affiliate of The Cleveland Worm & Gear Co.
Represented in Canada by Peacock Brothers, Limited

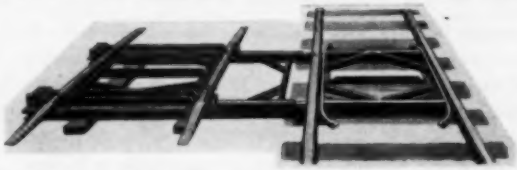
It will pay you to look over this issue from cover to cover

Any one of the 8 sections might contain the answer to your problems. Look over each one of them.

- Deep Mining Guidebook
- Strip Mining Guidebook
- Preparation Guidebook
- Maintenance Guidebook
- Supply Service Guidebook
- Safety Guidebook

When buying, or requesting product information, please be sure to mention COAL AGE Mining Guidebook and Buying Directory issue.

Quickly Self-Liquidating



THE FAMOUS "CANTON" AUTOMATIC MINE DOOR

The American Mine Door long ago eliminated trapper boys . . . saved countless lives . . . maintains trip speeds that increase output by thousands of tons . . . saves cash in electrical cost stopping and starting trips . . . snaps open—snaps shut.

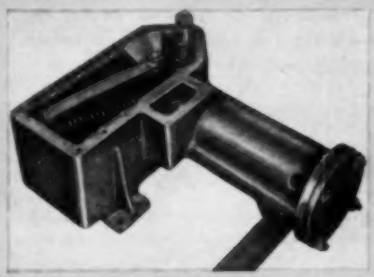
"CANTON" CAR TRANSFER

Loads entire train on a single track. No alterations whatever to the main track. Less rib to shoot than for jump switch. No hazards of cherry picker. Car always on wheels.

"Canton" Mining Equipment

THE "CANTON" DUSTMASTER

A powerful machine equipped with a 20 H.P. motor that will distribute 125 lbs. of dust per minute through 500 ft. of hose. Rigidly built. Minimum height from rail 25". Track mounted.

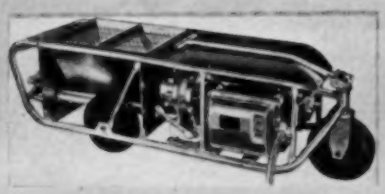


"CANTON" ELECTRI-THROW—DEPENDABLE SWITCH THROW

Throws switches automatically. No more hazards of men jumping off and on moving trips. Full trains go through at full speed. More tons of coal taken out, more profit per shift.

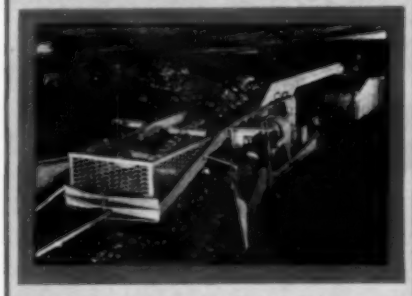
THE RUGGED "CANTON" MODEL 40 TRACK CLEANER

Tailored to your mine from 40" up in height. Removing 100 tons combustible spillage saves buying and applying up to 200 tons of rock dust. The "Canton" Track Cleaners save hundreds of dollars per mile in track cleaning costs. Pay for themselves in exceedingly short time. Clean all mines, hard and soft coal mines, iron and copper, potash and salt mines.



THE "CANTON" LITTLE CHIEF

Will dust anywhere. High pressure machine dusting through 1¼" hose . . . ups to 250 ft. Big capacity. Skid model for shuttle buggies, belts, or mine cars, also rubber tire model. Track mounted for haulage roads. Height 18" on skids, 22½" on tires.

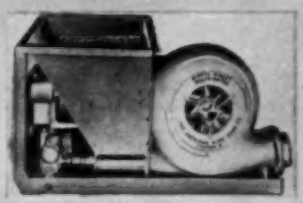


MODEL 30 TRACK CLEANER

Specially designed for low coal. Quick acting hydraulic adjusting, speeds up track cleaning. American Mine Door Company tailors the machine for 24" to 48" track gauge, and from 30" up in height.

"CANTON" QUICK-ON CABLE SPLICER

Reduce down time. Just pound around joined meshed ends of cable and go on working. No special tools required. A coupling pin or hammer will do. For neat non-snag joint, use Canton Cable Splicers and Canton Shop Vulcanizers.



THE "CANTON" MIGHTY MIDGET

Portable, weighs 280 lbs.—quickly moved from face to face to dust rooms as soon as loading machine departs. Ideal for small mines or dusty locations. Capacity 7 tons per shift. Inexpensive. Can be cart mounted.

THE AMERICAN MINE DOOR COMPANY

2057 DUEBER AVE. CANTON 6, OHIO

Let us install a "Canton" Product for you.

Pay us out of savings

Aeroquip Hose Lines with Reusable Fittings

With Aeroquip, hose line replacement on this strip mine scraper can be made right in the field. Hose assemblies are made in minutes, holding downtime to a minimum.

This Joy continuous miner is equipped with Aeroquip high pressure hydraulic lines. Hose lines to rotary head are armored to withstand external shock and abrasion.

SIMPLIFY DESIGN PROBLEMS

Aeroquip flexible hose lines offer these important advantages over rigid tubing systems: They install quickly and easily, even in confined spaces; they eliminate failures due to vibration; they withstand extreme heat, cold, and may be used with a wide variety of fluids. Complete engineering assistance is available to manufacturers of mining equipment.

SPEED FIELD MAINTENANCE

Aeroquip flexible hose lines can be made and installed right in the field, using a small supply of bulk hose and reusable fittings. The hose can be cut to length and fittings attached with ease . . . it takes only minutes and cuts downtime to a minimum.

Aeroquip 1503 single wire braid hose and reusable fittings are recommended for medium pressure hydraulic, lube and fuel oil, water and air lines for working pressure up to 1500 p.s.i. Available in sizes from 3/16" to 3".

Aeroquip 1509 double wire braid hose and reusable fittings are recommended for high pressure hydraulic, grease, fuel and air lines for working pressure up to 4500 p.s.i. Available in sizes from 1/4" to 2".

Aeroquip 1525 cotton braid hose and *SOCKETLESS* fittings are recommended for oil, fuel and air lines on engines and other low pressure applications up to 250 p.s.i. To assemble, just push the hose on the *SOCKETLESS* fitting. Ideal replacement for rigid tubing. In sizes from 1/4" to 5/8". (Patent Applied For.)

SELF-SEALING COUPLINGS

The Aeroquip self-sealing coupling allows quick connection and disconnection of lines carrying hydraulic fluids, hot engine oils, fuel, air and water. It replaces two shut-off valves. Each half seals automatically on disconnection.

Aeroquip Products Are Available Through Distributors Everywhere. See Your Yellow Pages.

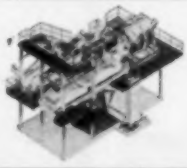
Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

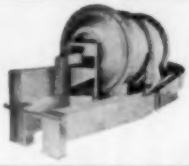
LOCAL REPRESENTATIVES IN PRINCIPAL CITIES IN U.S.A. AND ABROAD • AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

Wemco answers your coal cleaning problems



WEMCO HMS MOBIL-MILLS

World's most widely used heavy media separation plants; available with a choice of separatory vessels; capacities 25 to 500 TPH; will handle feed range from 8" to 3/32".



TWO-COMPARTMENT DRUM SEPARATORS

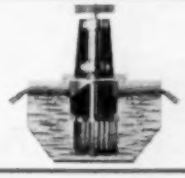
Two-gravity, three-product heavy media separation in one vessel. Less than 1% misplaced material on a feed of 114 TPH of 2½" x ¼" coal indicated in typical operating report.

WEMCO HMS EQUIPMENT FOR CUSTOM PLANTS

Separatory drums and cones, densifiers, medium pumps and media reclamation circuits of the superior designs so thoroughly proven in the Wemco Mobil-Mills.

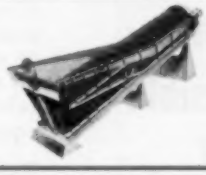
WEMCO TORQUE-FLOW SOLIDS PUMP

A remarkable new pump that can handle chunks up to several inches in diameter; available in capacities 100 to 3,000 GPM; handles heads up to 120 feet.



FAGERGREN FLOTATION MACHINES

Most efficient per cubic foot of all modern flotation machines. Extract saleable coal in the range from 14 to 325 mesh plus solving disposal problem.



WEMCO COAL SPIRALS

Efficient, low cost dewatering and/or sizing device that achieves more complete moisture removal than the drag tank; also fewer working parts and no stalling problems.

WEMCO HYDROSEPARATORS

High capacity means for making an efficient separation in the 200 mesh range; used to deslime coal ahead of tabling or flotation; diameters to 150 feet.

WEMCO LABORATORY SERVICES

All necessary tests are available to determine practicability of various coal cleaning methods for treating your run-of-mine coal.

WEMCO THICKENERS

The perfect compromise between acreage and horsepower in clarifying water for closed circuits, or for pollution-free stream disposal; diameters to 400 feet.

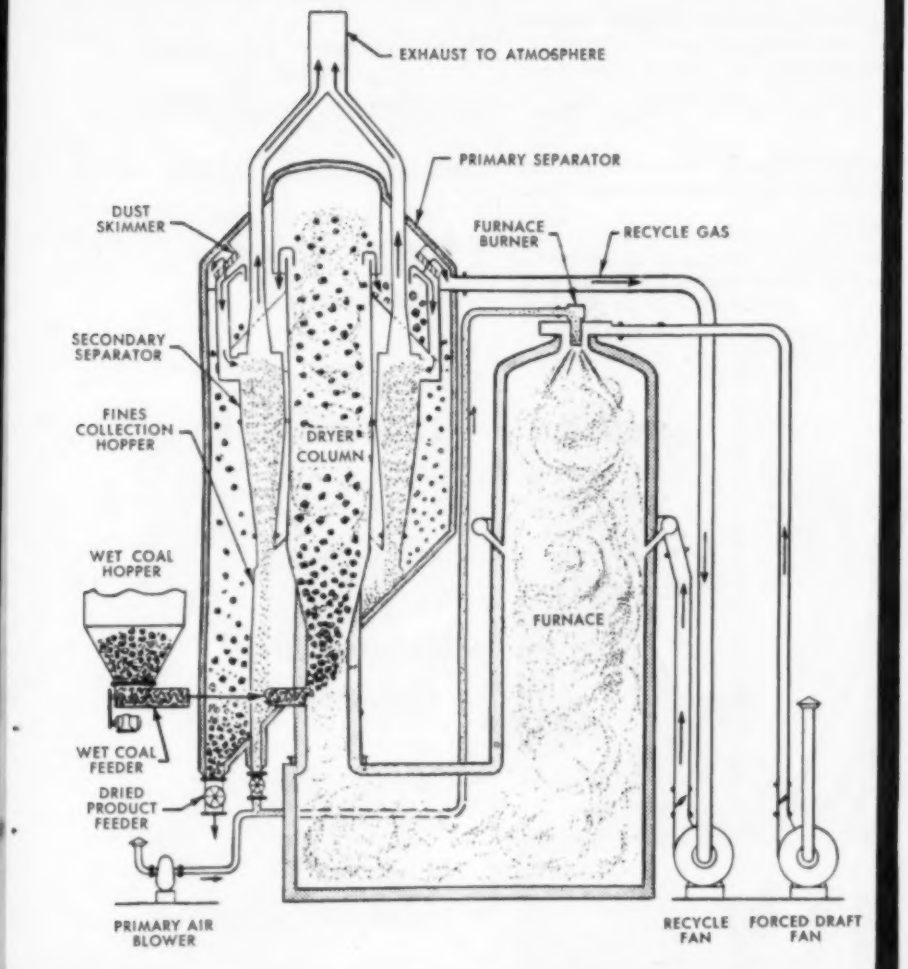
The full available information on any of the above equipment items will gladly be mailed in answer to your inquiry. More detailed recommendations for your specific coal cleaning problem will also be furnished, if desired. Write Dept. Y-2212

WEMCO
WESTERN MACHINERY COMPANY
760-766 FOLSOM STREET · SAN FRANCISCO 7, CALIFORNIA

Representatives in principal cities of the United States and Canada and in major countries throughout the world.

DRY YOUR COAL

for PENNIES PER TON in the...
...NEW PARRY TURBULENT ENTRAINMENT DRYER



Proved highly successful for over two years handling ½ x 0 mesh coal. Typical operating level: 30 TPH of wet coal...60% moisture, reducing to 5% moisture (50,000,000 BTU furnace). Thermal efficiencies are near 90%. Reduction to 1% moisture on demand.

Controlled temperatures and high rates of heat transfer remove combined and surface moisture in seconds. This is a continuous process, completely safe and economical through use of inert gases and positive pressure within the system.

Bulletin and engineering services on request.

SILVER ENGINEERING WORKS, INC.

3313 BLAKE STREET, DENVER 5, COLORADO

DESIGNERS AND MANUFACTURERS OF INDUSTRIAL AND PROCESS MACHINERY

AMERICAN PULVERIZER COMPANY

Originators and manufacturer of American Rolling Ring Coal Crushers

1275 Macklind Ave., St. Louis 10, Mo.
STerling 1-6100

REPRESENTATIVES

Atlanta, Ga., O'Shea Engineering Co., 305 Techwood Dr., N.W., CYpress 1656
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Charlotte 3, N.C., A. M. Stephenson, 1366 East Morehead St., Phone: 3-8483
Cheltenham, Pa., C. V. McQuarry, Box 52, Fidelity 2-5544 (Philadelphia)
Chicago 5, Ill., Mayer and Oswald, Inc., 407 S. Dearborn, Harrison 7-2040
Cincinnati 2, Ohio, Wyman Engineering, 105 West Fourth St., Main 2339
Cleveland 3, Ohio, Stephan Company, 7016 Euclid, Endicott 1-2109
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Pittsburgh 22, Pa., Titzel Engineering & Equipment Co., 132 7th St., 952 Century Bldg. Atlantic 1-0215

COMPLETE LINE

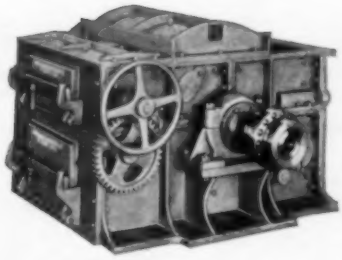
From large tonnage crushers wtih capacities up to 800TPH to Coal Sample Crushers, in a wide range of models and sizes, all custom designed to fit your specific operation.

EXPERIENCE

American has manufactured reduction equipment exclusively since 1908. American Rolling Ring Coal Crushers are in use all over the world and are famous for their dependability, low operating cost, and high output of uniform product.

ENGINEERING SERVICE

The Engineering Staff and experimental laboratory of American Pulverizer Co. provides a valuable service for analysis and recommendations of the proper type and size crusher for your operation.

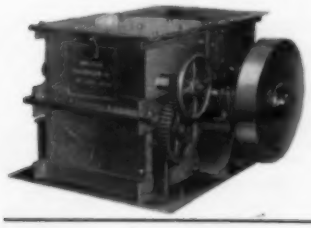


AMERICAN AC TYPE CRUSHERS

Capacities up to 800TPH. Extensively used for the reduction of ROM and lump coal to commercial screenings and stoker sizes. Operates at slow power saving speed, gives positive size control with a minimum of fines. Size of end product can be varied by external adjustments of grinding plate and drop cage.

Only American Crushers have the patented Rolling Shredder Rings which split coal instead of crushing it, thereby producing less fines.

Rings are made of manganese steel and are reversible to give double wear.

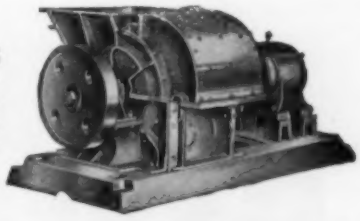


WC & WS SERIES

Made in 9 sizes with capacities up to 188 TPH. Very compact —makes ideal installation at mines or in yards underneath coal bin. External adjustments of Grinding Plate and Adjustable Drop Cage permits tailor made sizes to the truckload.

AMERICAN "S" TYPE CRUSHERS

Made in 8 sizes with capacities up to 500TPH for the reduction of ROM and lump coal to Screenings. Also used for crushing Middlings and Picking table refuse.

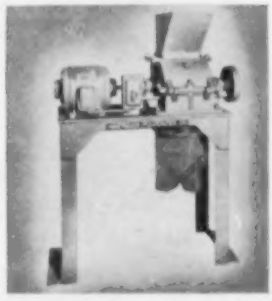


HEAVY DUTY "S" TYPE

Made in 4 sizes, with capacity up to 500 TPH. This Heavy Duty "S" Type Crusher reduces ROM Coal, gob, rock, slate, sulphur balls, etc. without oversize and eliminates the need for pickers. Pays for itself in short time in savings of labor and recovery of coal imbedded in impurities.

SAMPLE CRUSHERS

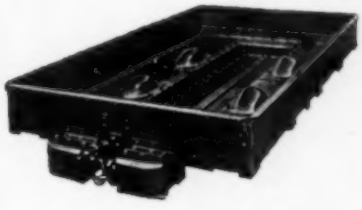
Made in two sizes with capacities up to 2000 lbs. per hour. Sampling hopper gives a 5%—10%—15%—20% Sample of The Sample—For larger capacities we recommend the American "WC" or "13" Series with capacities up to 12 TPH.



ENTERPRISE WHEEL & CAR CORPORATION

CUSTOM - ENGINEERED MINE CARS . . . . .

ENTERPRISE CARS are built for the mine—*not for the shop*



ENTERPRISE CARS are built to meet *every* mine specification

ENTERPRISE CARS give you *constant haulage* . . . no serious production delays. Repairs will not affect over-all mine operation

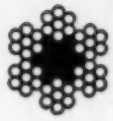
ENTERPRISE WHEELS are not made of ordinary cast iron. Enterprise wheels are made of chilled semi-steel—heat-treated for high tensile strength and shock resistance

ENTERPRISE TRUCKS can be furnished with either straight, tapered or ball bearings. In orders and inquiries, please include information regarding style truck, diameter of wheel and axle, track gauge, and wheel base

Your insurance against haulage delays and shut-downs . . .
. . . MINE CARS

An experienced mine car engineering and production organization, backed by 56 years' experience, is at your disposal. Write us your haulage requirements and problems.

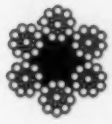
ENTERPRISE
WHEEL AND CAR CORPORATION
BRISTOL, VIRGINIA - TENNESSEE
HUNTINGTON, WEST VIRGINIA



6 X 7 CONSTRUCTION

FIBER CORE

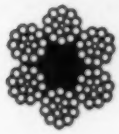
High abrasion resistance. Requires large operating sheaves and hoist drums. Well suited for some types of slope haulages especially when made Lang Lay.



6 X 19 SEALE CONSTRUCTION

FIBER CORE

Large outer wires enable this rope to withstand severe abrasion when operating on a slope haulage with medium sized sheaves and hoisting drums.



6 X 21 FILLER WIRE CONSTRUCTION

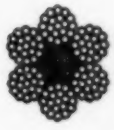
FIBER CORE

An ideal slope haulage rope for use where sheaves and hoisting drums are small.

6 X 25 FILLER WIRE CONSTRUCTION

FIBER CORE

An excellent shaft and haulage rope for underground operations.



6 X 25 FILLER WIRE CONSTRUCTION

INDEPENDENT WIRE ROPE CORE

This construction is often used on shovels and draglines in open pit or strip mining operations.

6 X 31 SEALE CONSTRUCTION

INDEPENDENT WIRE ROPE CORE

This special mining machine rope provides maximum flexibility and abrasion resistance. Made very limp and flexible to hug small heaves and drums tightly.

6 X 37 CONSTRUCTION

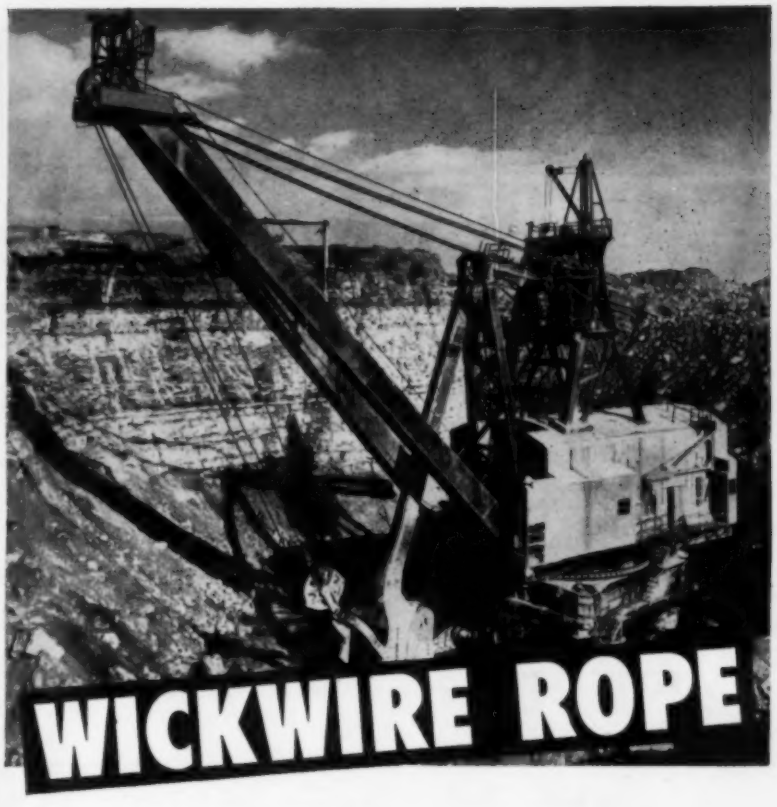
FIBER CORE

A special flexible core to be used in hoisting and mining machines where bending conditions are unusually severe, and where ratios of sheave and drum diameters to rope diameters are comparatively small.

18 X 7 CONSTRUCTION

FIBER CORE

A non-spinning hoisting rope, it is ideal for use as a single-part line because it restricts the rotation of the load.



for coal mining operations

Wickwire Rope is available in all sizes and types to meet every need in coal mining—whether it's a strip or underground operation.

Yet completeness of sizes and types tells only one part of the Wickwire story. The other is *quality*. This comes from the work of skilled craftsmen who have made wire rope their life's work as well as from a rigid system of quality controls throughout every stage of production—from ore to finished rope.

For the full story on how Wickwire Rope can help you in your own operations, just contact your Wickwire representative or the nearest sales office shown below.

BE SURE YOU "KNOW YOUR ROPES"

Our 82-page manual, "Know Your Ropes," is full of suggestions on the proper selection, application and use of wire rope. For your free copy, contact your Wickwire representative or write the nearest sales office shown below.

THE COLORADO FUEL AND IRON CORPORATION

Abilene (Tex.) • Denver • Houston • Odessa (Tex.) • Phoenix • Salt Lake City • Tulsa

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WICKWIRE SPENCER STEEL DIVISION

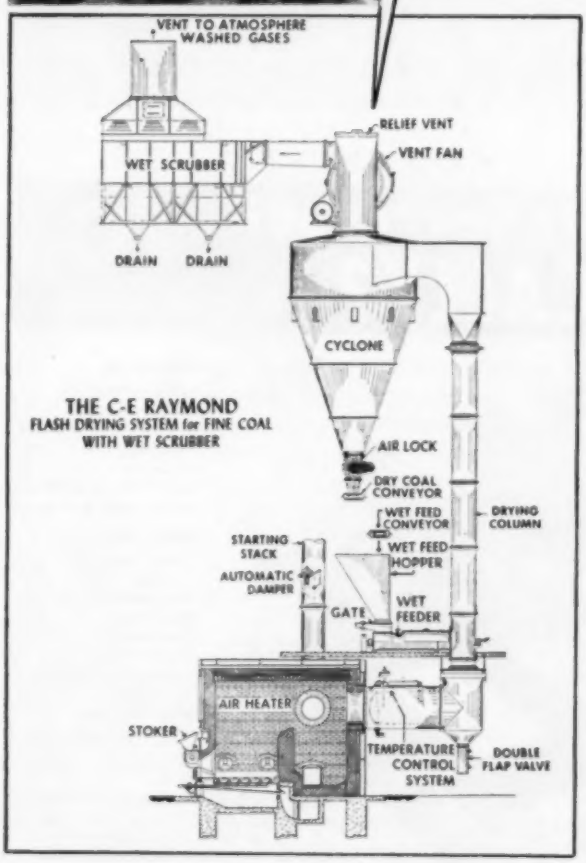
Boston • Buffalo • Chattanooga • Chicago • Detroit • Emlenton (Pa.) • New Orleans • New York • Philadelphia

3526

CF&I **WICKWIRE ROPE**

PRODUCT OF WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL AND IRON CORPORATION

THE C-E RAYMOND SYSTEM of FLASH DRYING FINE COAL



THE C-E RAYMOND FLASH DRYING SYSTEM for FINE COAL WITH WET SCRUBBER

C-E Raymond Flash Drying offers a rapid and economical method of removing moisture from fine coal ⅜" x 0, and providing an effective venting system that meets smoke control regulations.

For Large and Small Plants

Complete units are built for any capacity requirements. With a single drying column, **10 to 100 tons per hour of dried product can** be handled. Multiple drying columns connected to one furnace are furnished to order for larger capacities.

Highly Efficient Operation

Instantaneous drying action and the new type coal trap combine to eliminate the coal degredation problem even in the softer coals. Smooth, clean, automatic operation with low power consumption is a feature of this system.

Control of Air Pollution

Where the plant location is in a restricted area, a high efficiency *wet scrubber* is included. Dust loss in venting the air will not exceed 0.3 grains per cubic foot, which is well within the range of air pollution requirements.

Practical Advantages

Units of equipment are easy to install, and may be arranged to fit plant layout without major alterations. Close control is assured over final moisture content of the coal. The unit will handle dewatered fines, containing 25% to 6% moisture, and deliver a dried product with only 2% to 3% moisture.

Typical Flow Sheet for C-E Raymond Flash Drying System showing arrangement of units with air heater and wet scrubber

For further details, see Bulletin No. FD-51

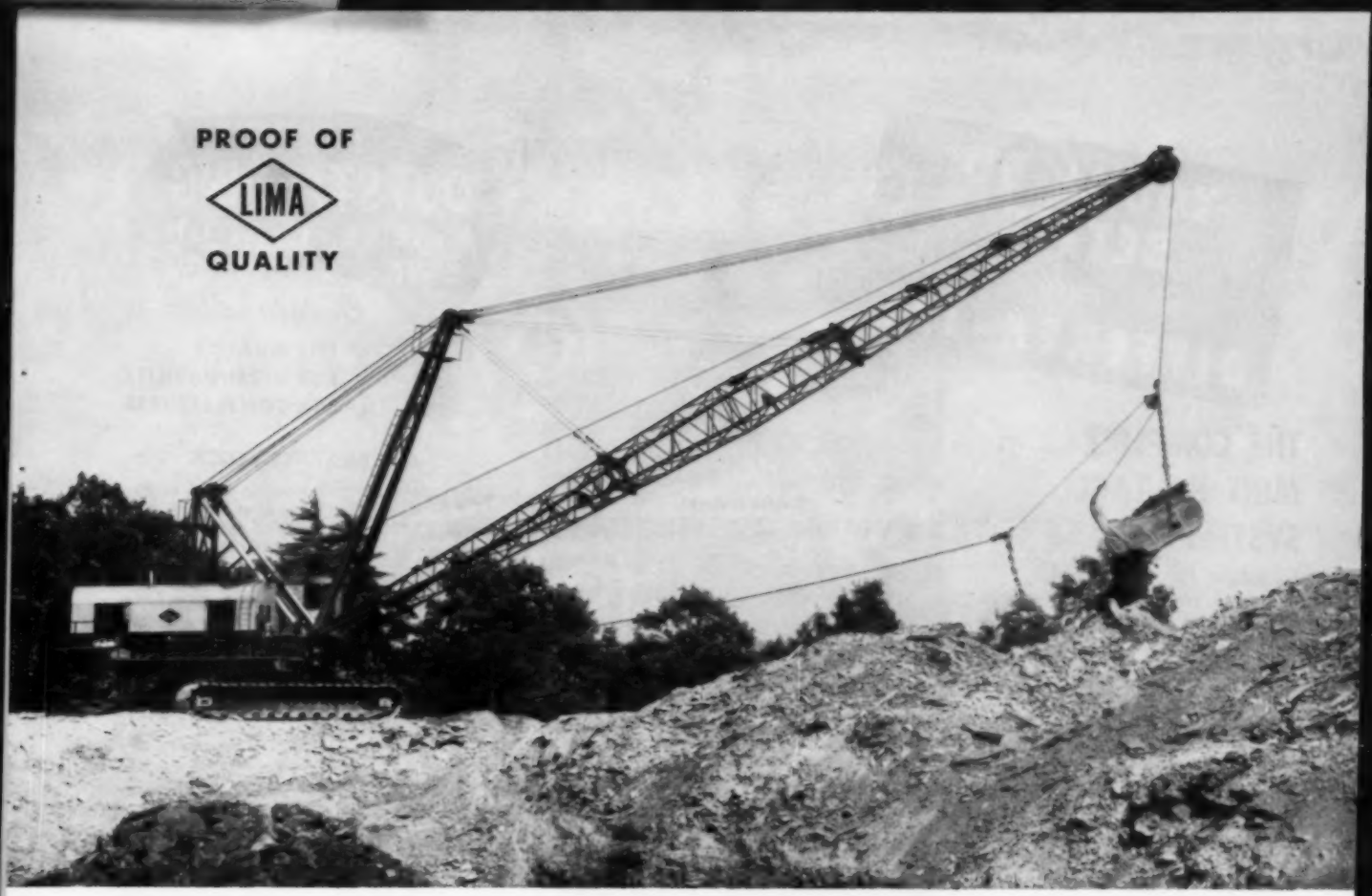
COMBUSTION ENGINEERING, INC.

Raymond Division

1315 North Branch St.
Chicago 22, Illinois

Sales Offices in Principal Cities

Combustion Engineering-Superheater Ltd.—Montreal, Canada



BAILEY COAL COMPANY REPORTS . . .

"Our two rugged Lima Type 2400 draglines strip overburden fast!"

Two big, rugged, fast-working Lima Type 2400 draglines pay real dividends in stripping operations for the Bailey Coal Company, Morrisdale, Pennsylvania. Lane Wrye, Job Foreman at Bailey's Gorton strip tells how:

"Our two Lima Type 2400s strip overburden fast! Their big capacity and high-speed operation get us down to the coal level in a hurry . . . whether we have to go through rock, shale or dirt. And these tough, stable machines travel and work anywhere, no matter how rough the footing.

"Our Limas can take the grind of round-the-clock operation, too. We worked our first 2400 through three shifts a day for over four years and the second machine for two years. In that kind of operation the full air controls on the machines are another big help. They let an operator work a full eight-hour shift at top speed and top efficiency."

Mr. Wrye concludes: "We've had excellent performance from our Limas. They've given us high speed stripping for more profitable operation every place we've used them."

Why not take a tip from the experience of Bailey Coal Co.? Equipped as a dragline or shovel, the six yard Lima Type 2400 can speed *your* stripping operations for greater profit. Like every machine in the Lima line, it's designed and built with the emphasis on quality to give you top performance on every job . . . without costly downtime. It will pay you to get complete details on the Type 2400—or other Limas with capacities best suited to your job requirements. Call your nearby Lima distributor today, or write Construction Equipment Division, Baldwin-Lima-Hamilton Corporation, Lima, Ohio.

One of Bailey Coal Co.'s Type 2400s, equipped with 110 foot boom, is shown removing shale at Gorton. The extra-wide, extra-long crawlers give the Type 2400 maximum stability.

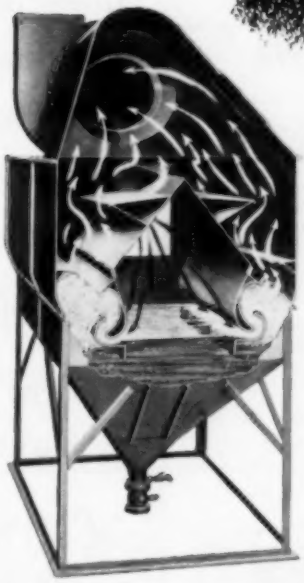
BALDWIN BLH LIMA-HAMILTON

LIMA SHOVELS · CRANES · DRAGLINES · PULLSHOVELS

BALDWIN-LIMA-HAMILTON

Construction Equipment Division · LIMA · OHIO · U. S. A.

Is COAL DUST a BLACK MARK against your operation?



Type N ROTO-CLONE—a high efficiency hydrostatic precipitator which cleans the air by the combined action of centrifugal force and thorough intermixing of water with dust-laden air. Unit illustrated designed for sluicing the collected coal dust to disposal point.

AMERclone dry centrifugal dust collector. Designed to handle large exhaust volumes containing abrasive dust in high concentrations.

AAF Dust Control Offers Practical Way to Improve Both Working Conditions and Community Relations

A cleaner place in which to work—a cleaner community in which to live. These are the benefits of dust control which are rapidly becoming associated with modern coal mining—and alert management.

Where can you put AAF Dust Control to work? For the coal dryer, a wet-type collector—the Type N ROTO-CLONE—has proved its efficiency and low cost operation on many installations. For material handling operations at the tipple, again it's the Type N or, if dust is to be collected dry, AAF's AMERclone dry centrifugal is your choice.

This year, as never before, large and small coal companies alike indicated their awareness of the benefits of dust control—and backed it up with record-breaking purchases of AAF equipment. Our engineers will be happy to show you how they have helped these operators to wipe the slate clean of coal dust problems. Write or call your nearby AAF representative now.

AAF herman nelson

American Air Filter
COMPANY, INC.

American Air Filter of Canada, Ltd., Montreal, P. Q. • 267 Central Avenue, Louisville 8, Kentucky

PROFESSIONAL SERVICES

SEARCHLIGHT SECTION

(Classified Advertising)

BUSINESS OPPORTUNITIES EQUIPMENT - USED or RESALE

UNDISPLAYED RATE:
1.20 a line, minimum 3 lines. To figure advance payment count 5 average words a line.
PROPOSALS, $1.20 a line an insertion.
BOX NUMBERS count as one line additional in undisplayed ads.
DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED RATE:
The advertising rate is $10.20 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.
AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page.
EQUIPMENT WANTED or FOR SALE ADVERTISEMENTS acceptable only in Displayed Style.

Send NEW ADVERTISEMENTS to N. Y. Office, 330 W. 42nd St., N. Y. 36, N. Y.

FOR SALE: MINE EQUIPMENT

Locomotives, 250-volt, D.C., 42" track gauge.
Three 6-ton Westinghouse, bar-steel frame, 904 motors.
Two 12-ton tandem, Westinghouse, bar-steel frame, 908 motors.
Three 13-ton General Electric 840-M motors.

Pumps, 5" x 6" and 4" x 6", Triplex, Deming, and Scranton.

Air Compressors, truck-mounted, Sullivan and Chicago Pneumatic.

Transformers, Three General Electric, 200 KVA, 22000-2300/4000Y volts.
Three Westinghouse, 400 KVA, 22000-2300 volts.
Three General Electric, 500 KVA, 22000-2300/4000Y volts

Shaft Hoist, Vulcan, Cylindro-conical drum 7' to 9', grooved for 1⅝" rope.

Hoists, one Lidgerwood: 75 HP motor, drum coils, 2200 ft. ⅞" rope.

Bradford Breaker, Pennsylvania Crusher Co.: 12" x 19', complete with housings, chutes, and conveyors.

Loading Booms, 60" apron-type.

Vibrating Screens, Jeffrey-Traylor: FB-2, FB-4.

Large stock of mine supplies, locomotive, mining-machine, and pump parts.

J. H. Hillman & Sons Company
Jerome Mine
Jerome, Somerset County, Pa.

or

J. H. Hillman & Sons Company
1914 Grant Building, Pittsburgh 19, Pa.

ANYTHING FOR THE COAL MINING INDUSTRY

Used & Rebuilt Mining Equipment

- Rail & Accessories
- Cutting Machines
- Shuttle Cars
- Locomotives
- Conveyors
- Loaders
- Rail & Accessories
- Preparation Equip.
- Electric Motors
- Sub Stations
- Mine Cars
- Hoists

A. C. MINING EQUIPMENT

We have just purchased a large mine which was fully equipped with battery equipment and 220/440 Volt AC equipment. This equipment is now being offered at bargain prices.

WANTED: Should you have one piece of Equipment or an entire mine for sale, please give us a ring and we will make inspection, giving you a fair offer immediately.

ELECTRIC & MACHINE SUPPLY COMPANY, INC.

Mining & Industrial Equipment

Whitesburg, Kentucky
P. O. Box 251
Phones: 2590 or 2594
Bill Conley

Melvin Adams

Clarksburg, West Virginia
P. O. Box 227
Phone: 3-0253
H. J. (Hank) Ubbing

RAILS-TIES
TRACK ACCESSORIES
NEW and RELAYING

SAVE ON RAILS

BUY "GUARANTEED RELAYERS"

Handle more cars better — spend less to install & maintain with Foster Relayers. "Open-stock" shipments, all sections 12# thru 175#. Switch Materials, Track items.

Send catalogs ☐ *Rails* ☐ *Track Equipment*
☐ *Send Free 'Track Maintenance' Book*

RAILS - TRACK EQUIPMENT - PIPE - PILING
L B FOSTER co.
PITTSBURGH 30 • NEW YORK 7 • CHICAGO 4
ATLANTA 8 • HOUSTON 2 • LOS ANGELES 5

RAILS...
BOUGHT AND SOLD
NEW AND RELAYING
M. K. FRANK
480 Lexington Ave., N. Y. 17, N. Y.

BOX CAR LOADERS
3—Ottumwa 20 HP box car loaders
2—Manierre 22 HP box car loaders
1—Jeffrey 20 HP box car loader
2—Red Devil portable loaders, 12" x 12"
1—Card portable loader, 11' x 19"

ROTARY DUMPER
1—Card Rotary car dumper, 13' x 15' platform

ELECTRIC HOISTS
1—11 HP Vulcan, single drum
1—20 HP Vulcan, single drum
1—22 HP Vulcan, double drum
1—25 HP Vulcan, single drum
1—30 HP Vulcan, single drum
1—37 HP single drum
5—50 HP single drum
2—60 HP single drum
4—100 HP Box single drum
1—112 HP Vulcan, single drum
1—150 HP Vulcan, single drum
1—150-225 HP Denver double drum
1—375 HP Box single drum

RAIL
We have in stock good relaying rail 16# to 100#, also new rail and fittings, 12#, 16# and 20#.

LOADERS & CONVEYORS
1—11BU Joy loader, 250V. D.C.
3—5BU Joy loaders, 250V. D.C.
1—61EW Jeffrey elevating chain conveyor
1—6HG Jeffrey chain conveyor, 90'
9—G-20 Goodman shakers
6—G-15 Goodman shakers
8—Vulcan shakers
2—UN-17 Joy LaDel shakers
10—Goodman HA duckbills

MINING MACHINES
A.C.
1—7B Sullivan super shortwall
16—Sullivan CE7
1—28A Jeffrey
5—112A Goodman

D.C.
3—7B Sullivan super shortwall
2—T-1 Joy crawler type trucks

SCALES
3—100 ton Fairbanks railroad scales
1—125 ton Howe railroad scales

COAL CARS
89—60 cu. ft. Card steel, end dump, 36" ga.
88—66 cu. ft. Card steel, end dump, 36" ga.
91—107 cu. ft. Watt steel, end dump, 42" ga.

SHUTTLE CARS
1—Joy model 42D5, battery operated
3—Joy model 60D3P, battery operated
7—Joy model 60D1, battery operated

MINE FANS
1—108" Joy La-Del axial flow fan, model L-14
1—8H Jeffrey 42" aerodyne fan
1—7' Jeffrey aerodyne 2 stage fan
1—3600 cfm Claridge blower, 3 HP

PICKING TABLES
1—20'x18" Link-Belt
1—41'6"x30" Card
1—51'x48" Card
1—73'x30"
1—64'x48"

BATTERY LOCOMOTIVES
2—2½-3½ ton Mancha, 24" ga.
1—4 ton Westinghouse, 24" ga.
1—4 ton Ironton, 36" ga.
2—5 ton General Electric, 36" ga.
2—7 ton General Electric, 36" ga.
3—8 ton Ironton, 36" ga.
2—8 ton General Electric, 36" ga.
2—8 ton Goodman, 36" ga.
4—10 ton Atlas, 36" ga.

TROLLEY LOCOMOTIVES
1—2½ T. Jeffrey, 36" ga.
1—4½ T. Goodman, 36" ga.
1—5 T. Jeffrey, 36" ga.
1—6 T. Goodman, 36" ga.
1—6 T. Goodman, 42" ga.
2—8 T. Goodman, 42" ga.
3—10 T. Jeffrey, 42" ga.
1—13 T. Goodman, 42" ga.
1—13 T. Jeffrey, 42" ga.
3—15 T. Jeffrey, 42" ga.

BATTERY CHARGERS
1—8.2 KW G. E. 150/182 V., 15 HP motor, 440V, AC
1—8.5 KW Hertner, 103/120 V., 15 HP motor, 440V, AC
1—10 KW Hertner, 150/181 V., 15 HP motor, 440V, AC
1—11.5 KW West., 125 V., 17.5 HP, 440 V AC motor
1—15 KW Elec. Prod. 132 V., 30 HP motor, 440 V AC
1—50 KW Hertner, 135 V., 75 HP motor, 440 V, AC
4—250 V D.C. battery charging switchboards
1—Joy battery charger, model U-248-20GE 128.5 volts 25 HP motor, 440 volts AC
1—Joy battery charger, model U-248-20GE 128.5 volts 30 HP motor, 250 volts DC
2—Joy battery chargers, model U-248-BE3 123.5 volts, 15 HP motors, 250 volts DC
3—Wooten type P-48, 132 V., 30 HP motors, 250 V. DC

ROCK DUSTERS
1—M.S.A. type A, 2 HP 250 V. DC motor
1—M.S.A. type A, 440 V. AC motor
1—M.S.A. #S-1103, 20 HP 230 V. DC motor

Since 1898 Dependable Reconditioned Machinery

MORSE BROS., MACHINERY CO.

2900 BRIGHTON BLVD EST. 1898 DENVER 1, COLO.

PENNSYLVANIA CRUSHER DIVISION

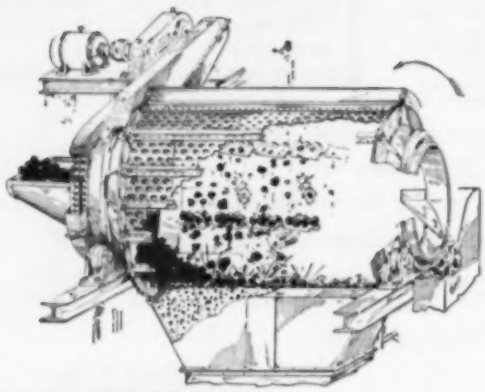
BATH IRON WORKS CORPORATION

ROOM 1711, WEST CHESTER, PA.

New York—Pittsburgh—Detroit—Chicago—St. Louis—Crosby, Minn.

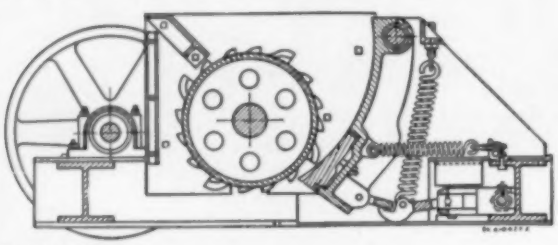
Los Angeles—Tampa—Houston—Denver—El Paso—London, England

CRUSHERS FOR THE COAL INDUSTRY



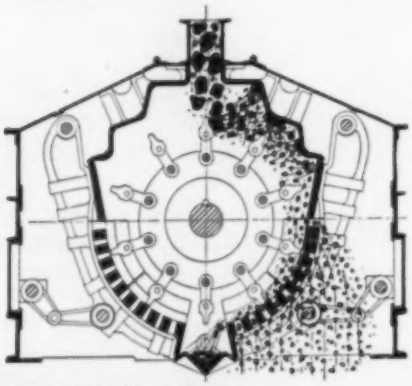
BRADFORD BREAKER

Conditions coal for cleaning, removes debris, eliminates oversize, produces uniform sizes with minimum fines and makes full seam mining practical and economical. Send for Bulletin No. 3007.



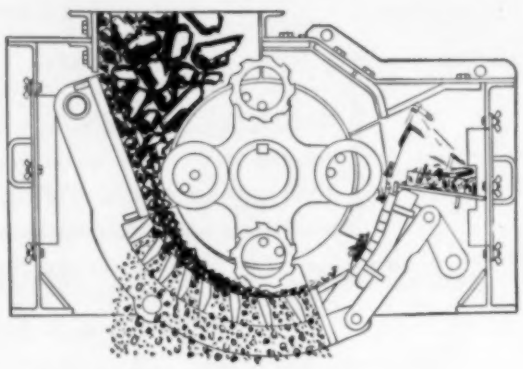
SINGLE ROLL

For reducing ROM hard and soft coals down to as small as 1" and under—crushing refuse at mines and cleaning plants—preparation of stoker coals. Send for Bulletin No. 2007.



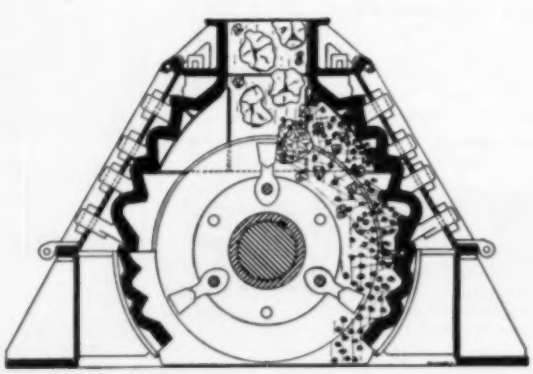
REVERSIBLE HAMMERMILL

For secondary reduction of coal to stoker size or finer. Since most of the crushing is done by impact and a minimum by attrition, this crusher delivers a uniform product at high reduction ratios with less overgrinding than any other hammermill known. Send for Bulletin No. 1040.



GRANULATOR

A ring type hammermill with a patented method of suspending the ring hammers to produce less fines than other hammermills. Ideal for preparing pulverizer and stoker coals and for crushing middlings. Cage assembly is *adjustable*, can be quickly moved either toward or away from the path of the crushing rings—*and the adjustment is positive!* The operator compensates for wear simply by moving the cage assembly closer to the crushing rings, thus keeping desired clearance and getting a *standard* product throughout the Granulator's long working-part life. As the Granulator crushes, it *automatically* traps "out-law", iron and other metallics often present in ROM coal and other feeds. Too big to escape between the cage bars, and relatively uncrushable, this tramp iron and debris is thrown along by the crushing rings until it reaches the limit of the cage and falls into a "trap," or pocket, easily accessible through an inspection and maintenance door.Send for Bulletin No. 9002.



IMPACTOR

Reduction is by impact, no attrition, thus this crusher is ideal for low cost crushing of washery and mine refuse and for separating coal from bone and rock. Send for Bulletin No. 6016.

The 1955 Coal Age Mining Guidebook . . .

Buying Directory

Equipment . . . Materials . . . Services

Who Supplies It?

Equipment, materials and services for coal mining, together with the names of those who furnish them, are shown in Part 1 of this Buying Directory, starting on the next page.

All products, materials and services, with their suppliers in each instance, are listed alphabetically under the key words. For example, look for "Bearings, Roller," rather than "Roller Bearings." If a product does not appear under one possible classification—for example, "Cable, Welding" — look for the alternative listing—in this instance,"Welding Cable."

TRADE NAMES—Where trade names have been provided by manufacturers, they are shown following the manufacturers' names under the appropriate product headings as an additional aid in locating sources of supply.

PRODUCT INFORMATION—The names of manufacturers and suppliers providing more detailed data on available equipment, materials and services through special product-information advertisements in this issue are shown in BLACK-FACED TYPE. To locate the advertisement of a specific manufacturer, consult the Advertising Index on p 242 of this issue, or the Directory of Manufacturers beginning on p 234.

Where Are They?

The addresses of the manufacturers, suppliers and service organizations appearing in the Buying Directory are listed under the company names in the Directory of Manufacturers beginning on p 234 of this issue

Black-faced type indicates a product-information advertisement in this issue. To locate, see Advertising Index, p 242, or Directory of Manufacturers, beginning on p 234.

ACETYLENE GENERATORS
Linde Air Products Co., Div. Union Carbide Carbon Corp.
Sight Feed Generator Co.

ADDING MACHINES, CALCULATORS
Geo-Optic Co., Inc.

ADDITIVES, FUEL OIL
Monsanto Chemical Co., Organic Chemicals Div.

ADDITIVES, FUEL OIL, LUBRICANTS
duPont de Nemours & Co., Inc., E. I.
Keystone Lubricating Co.
Sinclair Refining Co.
Swan Finch Oil Corp.—"MOTUL-ADDIT," "SAFCO-SOLU"
Warren Refining & Chemical Co.—"PVR"

ADDITIVES, LUBRICANTS
Dixon Crucible Co., Joseph

AERATORS
Bin-Dicator Co.—"BIN-FLO"

AERIAL PLATFORMS
Pitman Mfg. Co.—"Giraffe"

AERIAL SURVEYORS, MAPPING
Aerial Surveys, Inc.
Aero Service Corp.
Ammann, Jack, Photogrametric Engineers
Fairchild Aerial Surveys, Inc.
Geo-Optic Co., Inc.
Manu-Mine Research & Development Co.

AERIAL TRAMWAYS
Arrowhead Steel Buildings, Inc.
Interstate Equipment Div., Yara Engineering Corp.
Roebling's Sons Co., John A., Sub. Colorado Fuel & Iron Corp.

AFTERCOOLERS, OILERS, ACCESSORIES
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Gardner-Denver Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Pennsylvania Pump & Compressor Co.
Worthington Corp.

AGITATOR-CONDITIONERS
WEMCO Div., Western Machinery Co.

AIR CLEANERS, COAL
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

AIR COMPRESSORS, PORTABLE, MINE
Acme Machinery Co.
Cardox Corp.—"AIRDOX"
Davey Compressor Co.
Gardner-Denver Co.
Goodman Mfg. Co.
Imperial-Cantrell Mfg. Co.
Ingersoll-Rand Co.
Joy Mfg. Co.—"MINE AIR"
Le Roi Div., Westinghouse Air Brake Co.
Morse Bros. Machinery Co.
Worthington Corp.

AIR COMPRESSORS, PORTABLE, SURFACE
American Brake Shoe Co.
Cardox Corp.—"AIRDOX"
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Gardner-Denver Co.
Ingersoll-Rand Co.
Jaeger Machine Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Manu-Mine Research & Development Co.
Morse Bros. Machinery Co.
Schramm, Inc.
Worthington Corp.

AIR COMPRESSORS, SELF-PROPELLED
Schramm, Inc.—"PNEUMATRACTOR"

AIR COMPRESSORS, STATIONARY
Acme Machinery Co.
Allis-Chalmers Mfg. Co.—"RO-FLO"
American Brake Shoe Co.
Cardox Corp.—"AIRDOX"
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Gardner-Denver Co.
Ingersoll-Rand Co.
Jaeger Machine Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Morse Bros. Machinery Co.
Pennsylvania Pump & Compressor Co.
Roots-Connersville Blower, Div. Dresser Industries, Inc.
Schramm, Inc.
Worthington Corp.

AIR-LINE LUBRICATORS
Cleveland Rock Drill Div., Westinghouse Air Brake Co.
Ingersoll-Rand Co.

AIR SEPARATORS, MECHANICAL
Combustion Engineering, Inc., Raymond Div.

AKREMITE PACKAGING
Visking Corp., Plastics Div.—"VISQUEEN"

AMMONIUM NITRATE
duPont de Nemours & Co., Inc., E. I.
Hercules Powder Co.
Spencer Chemical Co.—"SPENCER"

ANALYZERS, COAL SULPHUR
Laboratory Equipment Corp.—"LECO"

ANEMOMETERS
Bruning Co., Inc., Charles
Dietzgen Co., Inc., Eugene
Fisher Scientific Co.
Gurley, W. & L. E.
Keuffel & Esser Co.
Mine Safety Appliances Co.
National Mine Service Co.

ANTI-FOG GOGGLE CLEANER
American Optical Co.

ANTIFREEZE, AIR COMPRESSORS
American Chemsol Co.

ARMATURE TESTERS
Complete Reading Electric Co., Inc.
Martindale Electric Co.
National Mine Service Co.
Snap-On Tools Corp.—"SNAP-ON"

ARMATURE REWINDING
Flood City Brass & Elec. Co.
Hannon & Sons, F. R.
Industrial Machine & Electric Co.
Jeffrey Mfg. Co.
Martindale Electric Co.
National Electric Coil Co.
National Mine Service Co.
Pennsylvania Electric Coil Co.
Scranton Electric Construction Co.
West Virginia Armature Co.

ATTRITION MACHINES
WEMCO DIV., Western Machinery Co.—"WEMCO"

AUGERS
McLaughlin Mfg. Co., Inc.

AUGERS, BREAST
Salem Tool Co.—"SALEM"

AUGERS, COAL BLASTHOLE
Carboloy Dept., General Electric Co.
Central Mine Equipment Co.

AUGERS, COAL RECOVERY
Cardox Corp.
Compton, Inc.
Joy Mfg. Co.
Salem Tool Co.—"MC CARTHY," "SALEM"

AUGERS, EARTH
Central Mine Equipment Co.

AUGERS, ROCK
Central Mine Equipment Co.

AXES, MINER'S
Salem Tool Co.—"SALEM"

AXLE BEARINGS, BRONZE
American Crucible Prods. Co.

AXLES
Gibraltar Equip. & Mfg. Co.

AXLES, MINE EQUIPMENT
ACF Industries, Inc.
Bethlehem Steel Co.
Card, C. S., Iron Works Co.
Flood City Brass & Electric Co.
Enterprise Wheel & Car Corp.
Ironton Engine Co.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Mining Machine Parts, Inc.
National Mine Service Co.
Phillips Div., Salem-Brosius, Inc.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.
Watt Car & Wheel Co.
West Virginia Armature Co.

BACKSTOPS
American Pulley Co.
Bonded Scale & Machine Co.
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Fairfield Engineering Co.
James Gear Mfg. Co., D. O.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.—"LINK-BELT"
Marland One-Way Clutch Co.
McNally Pittsburg Mfg. Corp.
Transall, Inc.
Universal Engineering Co.

BACKSTOPS, ONE-WAY ROLLER
Marland One-Way Clutch Co.

BAGS, AIR-FILTER
Ducon Co.
National Filter Media Corp.
Pangborn Corp.
U. S. Hoffman Machinery Corp.

BAGS, POLYETHYLENE
Bemis Bros. Bag Co.
Eimco Corp.
Fulton Bag & Cotton Mills
Tamping Bag Co.
Visking Corp., Plastics Div.

BAGS, POWDER
American Brattice Cloth Corp.

BAGS, RUBBER
Continental Rubber Works

BAGS, TAMPING
American Cyanamid Co., Explosives Dept.
Dooley Bros.
Fulton Bag & Cotton Mills
King Powder Co., Inc.
National Mine Service Co.
Tamping Bag Co.

BARGE-HANDLING EQUIPMENT
Davis Co., Nelson L.
Dravo Corp.
Jeffrey Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Wellman Engineering Co.

BARGES
Dravo Corp.

BAROMETERS
Bristol Co.—"BRISTOL'S"
Bruning Co., Inc., Charles
Fisher Scientific Co.
Mine Safety Appliances Co.
National Mine Service Co.

BARS, APPLICATOR
Stulz-Sickles Co.—"MANGANAL"

BARS, SLATE
Salem Tool Co.—"SALEM"

BASKETS, CLOTHES
Moore Co.—"MOORE LOCKERBASKET"

BATTERIES, DRY
National Carbon Co., Div. Union Carbide & Carbon Corp.—"EVEREADY"

BATTERIES, STORAGE
C & D Batteries, Inc.—"SYLVER-CLAD"
Compton, Inc.
Edison Storage Battery Div., Thomas A. Edison, Inc. — "EDISON NICKEL-IRON-ALKALINE"
Exide Industrial Div., Electric Storage Battery Co.
Goodrich Co., B. F., Tire & Equipment Div.
Gould-National Batteries, Inc.
Graybar Electric Co., Inc.
Greensburg Machinery Co.
K. W. Battery Co.—"KW"
National Mine Service Co.

BATTERY-CHARGING EQUIPMENT
Electric Products Co.
Exide Industrial Div., Electric Storage Battery Co.
Federal Telephone & Radio Co.
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.
Goodrich Co., B. F., Tire & Equipment Div.
Gould-National Batteries, Inc.
Graybar Electric Co.
Hobart Brothers—"HOBART"
Ironton Engine Co.
Kersey Mfg. Co.
Lincoln Electric Co.—"PRECISION CHARGE"
National Mine Service Co.
Rapid Electric Co.
Syntron Co.
Westinghouse Electric Corp.

BATTERY TEST CLAMPS
Trico Fuse Mfg. Co.—"KLIPLOK"

BEARING METAL
American Brake Shoe Co.
Haynes Stellite Co., Div. Union Carbide & Carbon Corp.
Johnson Bronze Co.
Keystone Carbon Co.
Ryerson & Son, Inc., Joseph T.
West Virginia Armature Co.

BEARING METAL, POWDERED BRONZE & IRON
Pure Carbon Co.

BEARINGS, BALL
Ahlberg Bearing Co.
Bantam Bearings Div., Torrington Co.
Bearings, Inc.
Bearing Service Co.
Complete Reading Electric Co., Inc.
Dodge Mfg. Corp.—"SC"
Fafnir Bearing Co.
Federal-Mogul Service—"B.C.A."
Flood City Brass & Electric Co.
General Motors Corp., New Departure Div.
Link-Belt Co.—"LINK-BELT"
Marlin Rockwell Co.—"M-R-C"
Mosebach Electric & Supply Co.
Norma-Hoffman Bearing Corp.
SKF Industries, Inc.
Stephens-Adamson Mfg. Co.
Tracy Co., Bertrand P.
Transall, Inc.
Westinghouse Electric Corp.
West Virginia Armature Co.
Woods Sons Co., T. B.—"LIFE-LUBE"

BEARINGS, CARBON
Helwig Co.

BEARINGS, NEEDLE
Bantam Bearings Div., Torrington Co.
Bearings, Inc.
Bearing Service Co.
Christian Engineers, J. D.
McGill Mfg. Co., Inc.
National Mine Service Co.
Orange Roller Bearing Co., Inc.
Torrington Co.
Westinghouse Electric Corp.

BEARINGS, ROLLER
Bantam Bearings Div., Torrington Co.
Bearings, Inc.
Bearing Service Co.
Bower Roller Bearing Co.
Chain Belt Co.—"SHAFER," "CONCAVEX"
Continental Gin Co., Industrial Div.
Dodge Mfg. Corp.—"DODGE-TIMKEN"
Enterprise Wheel & Car Corp.
Federal-Mogul Service—"BOWER"
Helmick Foundry-Machine Co.
Hyatt Bearings Div., General Motors Corp.
Link-Belt Co.—"LINK-BELT"
Marlin-Rockwell Corp.—"M-R-C"
McGill Mfg. Co., Inc.
McNally Pittsburg Mfg. Corp.
Mosebach Electric Supply Co.
National Mine Service Co.
Norma-Hoffman Bearing Corp.
Orange Roller Bearing Co., Inc.
Rollway Bearing Co., Inc.
SKF Industries, Inc.
Timken Roller Bearing Co.
Torrington Co.
Tracy Co., Bertrand P.
Transall, Inc.
Westinghouse Electric Corp.
West Virginia Armature Co.

BEARINGS, ROLLER, SPLIT
Cooper Split Roller Bearing Corp.

BEARINGS, ROLLER THRUST
Rollway Bearing Co., Inc.

BEARINGS, SLEEVE
American Brake Shoe Co.
American Crucible Products Co.
Bearings, Inc.
Chain Belt Co.—"REX"
Complete Reading Electric Co., Inc.
Dodge Mfg. Corp.—"SLEEVOIL"
Federal-Mogul Service—"FEDERAL-MOGUL"
Flood City Brass & Elec. Co.
Imperial-Cantrell Mfg. Co.
Johnson Bronze Co.
Keystone Carbon Co.
Link-Belt Co.—"LINK-BELT"
McNally Pittsburg Mfg. Corp.
Mosebach Electric & Supply Co.
National Mine Service Co.
Tracy Co., Bertrand P.
Westinghouse Electric Corp.
West Virginia Armature Co.

BEARINGS, SLEEVE, CARBON
Pure Carbon Co.

BEARINGS, SLEEVE, CONVERSION
Bearings, Inc.
Johnson Bronze Co.
Westinghouse Electric Corp.
West Virginia Armature Co.

BEARINGS, TAPERED-ROLLER, CAGE & CAGELESS
Tyson Bearing Co., Sub. SKF Industries, Inc.

BEARINGS, THRUST
Norma-Hoffman Bearing Corp.

BELT-LOADING STATIONS, AUTOMATIC
Stamler Co., W. R.

BELTS, CONVEYOR, ELEVATOR
Boston Woven Hose & Rubber Co.

BELTS, FLAT TRANSMISSION
Boston Woven Hose & Rubber Co.
Browning Mfg. Co.
Carlyle Rubber Co.
Cincinnati Rubber Mfg. Co.
Gates Rubber Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co., Inc.
Hamilton Rubber Mfg. Corp.
Hewitt-Robins, Inc.—"AJAX," "CONSERVO," "HAMMERMILL"
Houghton & Co., E. F.—"VIM TRED LEATHER"
Manhattan Rubber Div., Raybestos-Manhattan, Inc.
Manheim Mfg. & Belting Co.—"VEELOS"
New York Belting & Packing Co.—"KABLE KORD," "TEST SPECIAL"
Quaker Rubber Corp., Div. H. K. Porter Company, Inc., of Pittsburgh
Republic Rubber Div., Lee Rubber & Tire Corp.
Savage Co., W. J.
Scandinavia Belting Co.
Thermoid Co., Industrial Div.
Transall, Inc.
United States Rubber Co., Mechanical Goods Div.

BELTS, V
Allis-Chalmers Mfg. Co.—"TEXROPE"
American Pulley Co.—"WEDGBELT"
Bonded Scale & Machine Co.
Boston Woven Hose & Rubber Co.
Browning Mfg. Co.
Carlyle Rubber Co.
Christian Engineers, J. D.
Continental Gin Co., Industrial Div.
Dayton Rubber Co.—"THOROBRED," "SUPER-THOROBRED," "COG-BELT"
Dodge Mfg. Corp.—"SEALED LIFE," "SPECIAL DUTY"
Flood City Brass & Electric Co.
Gates Rubber Co.—"VULCO"
Goodall Rubber Co.
Goodrich, B. F., Industrial Products Div.
Goodyear Tire & Rubber Co., Inc.
Jones Foundry & Machine Co., W. A.
Link-Belt Co.—"LINK-BELT"
Manhattan Rubber Div., Raybestos Manhattan, Inc.
Manheim Mfg. & Belting Co.—"VEELOS"
National Mine Service Co.
New York Belting & Packing Co.—"GILMER"
Quaker Rubber Corp., Div. H. K. Porter Company, Inc., of Pittsburgh

Thermoid Co., Industrial Div.
Transall, Inc.
United States Rubber Co., Mechanical Goods Div.
Worthington Corp.
Woods Sons Co., T. B.—"SURE-GRIP"

BELTS, V-LINK

Manheim Mfg. & Belting Co.—"VEELOS"

BENDERS, PIPE, CONDUIT

Blackhawk Mfg. Co.—"PORTO-POWER"

BINDERS, LOAD

Coffing Hoist Div., Duff-Norton Co.

BIN CHUTES, GATES

American Brake Shoe Co.
Bartlett, C. O., & Snow Co.
Christian Engineers, J. D.
Construction Machinery Co.
Enterprise Wheel & Car Corp.
Helmick Foundry-Machine Co.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Koehring Co.
Link-Belt Co.—"LINK-BELT"
Mahon Co., R. C.
Mayo Tunnel & Mine Equipment Co.
McNally Pittsburg Mfg. Corp.
Neff & Fry Co.
Prins & Associates, K.
Roberts & Schaefer Co., Sub Thompson-Starrett Co., Inc.
Savage Co., W. J.
Stephens-Adamson Mfg. Co.
Straub Mfg. Co.
Thomas Engineering & Construction Co.
Transall, Inc.
U. S. Hoffman Machinery Corp.
Webb Corp.
Wilmot Engineering Co.

BIN-LEVEL INDICATORS

B-I-F Industries, Inc., Omega Machine Co. Div.
Bin-Dicator Co.—"BIN-DICATOR"
Convair Corp.—"BIN-VUE"
Fairfield Engineering Co.
Hewitt-Robins, Inc.—"ROBINTRONIC"
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Neff & Fry Co.
Stephens-Adamson Mfg. Co.
Syntron Co.
Transall, Inc.

BIN VIBRATORS

Cleveland Vibrator Co.
Kanawha Mfg. Co.
Neff & Fry Co.
Syntron Co.—"PULSATING MAGNET"
Tyler Co., W. S.—"TY-SPEED"

BINS, ASH-STORAGE

United Conveyor Corp.

BINS, PARTS STORAGE

Frick-Gallagher Mfg. Co.—"ROTABIN"

BINS, STORAGE

Lippmann Engineering Works
Pioneer Engineering Works, Inc.
Savage Co., W. J.

BINS, STORAGE, BLENDING

Armco Drainage & Metal Products, Inc.
Christian Engineers, J. D.
Davis Co., Nelson L.
Enterprise Wheel & Car Corp.
Fairmont Machinery Co.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Kanawha Mfg. Co.
Koehring Co.
Link-Belt Co.—"LINK-BELT"
Marietta Concrete Corp.—"MARIETTA"
Marsh Engineering Co., E. F.
Neff & Fry Co.
Prins Associates, K.
Red Jacket Co., Inc.
Thomas Engineering & Construction Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.
U. S. Hoffman Machinery Corp.
Universal Engineering Co.
Webb Corp.
Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc.

BIT BOXES

Duquesne Mine Supply Co.

BIT SHARPENERS

Bucyrus-Erie Co.
Carboloy Dept., General Electric Co.
Ingersoll-Rand Co.
National Mine Service Co.

BIT-SHARPENING SERVICE

Howells Mining Drill Co.
Vascoloy-Ramet Corp.

BIT-SHARPENING SERVICE, DIAMOND

Hoffman Brothers Drilling Co.

BITS, COAL

Central Mine Equipment Co.

BITS, PERCUSSION, RECONDITIONING

Howells Mining Drill Co.

BITS, ROCK

Central Mine Equipment Co.

BLASTING AGENTS

du Pont de Nemours & Co., Inc., E. I.—"AKREMITE," "NITRAMON," "NITRAMEX," "NITRAMITE" "PELLETOL"

BLASTING CAPS

American Cyanamid Co., Exposives Dept.
Atlas Powder Co.
Dooley Bros.
du Pont de Nemours & Co., E. I.
Hercules Powder Co.
Illinois Powder Mfg. Co.—"GOLD MEDAL BRAND"
King Powder Co., Inc.
National Powder Co.
Olin Mathieson Chemical Corp., Explosives Div.—"OLIN"

BLASTING MACHINES

American Cyanamid Co., Explosives Dept.
Atlas Powder Co.—"SHOTMASTER"
Dooley Bros.
duPont de Nemours & Co., Inc., E. I.
Femco, Inc.
Hercules Powder Co.
Illinois Powder Mfg. Co.
King Powder Co., Inc.
National Powder Co.
Olin Mathieson Chemical Corp., Explosives Dept.

BLASTING WIRE

Salem Tool Co.—"BLACK DIAMOND"

BLOCK SIGNALS, AUTOMATIC

Nachod & U. S. Signal Co.

BLOCKS, CRANE-HOOK

Upson-Walton Co.

BLOCKS, WIRE ROPE

American Hoist & Derrick Co.

BLOWERS, CENTRIFUGAL, MULTISTAGE

Hoffman Machinery Corp.

BLOWERS, CIRCULATING, DRAFT

American Blower Corp.
Campbell Co., E. K.—"EKCCO"
Clarage Fan Co.
Ingersoll-Rand Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.—"AXIVANE"
Morse Bros. Machinery Co.
Robinson Ventilating Co.
Wing Mfg. Co., L. J.

BLOWERS, CLEANING, MAINTENANCE

Holub Industries
Ideal Industries, Inc.
Martindale Electric Co.

BLOWERS, JIG

Roots-Connersville Blower, Div. Dresser Industries, Inc.

BLOWERS, PORTABLE, MINE

Chelsea Fan & Blower Co.—"OCTOPUS"
Coppus Engrg. Corp.—"VANO, VENTAIR"
Herold Mfg. Co.
Ilg Electric Ventilating Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.—"AXIVANE"
Robinson Ventilating Co.

BLUE, PHOTO & WHITE PRINTING EQUIPMENT, MATERIALS

Bruning Co., Charles—"COPYFLEX"
Keuffel & Esser Co.

BOILERS

Combustion Engineering Inc., Raymond Div.

BOILERS, HEATING

Axeman-Anderson Co.
Combustion Engineering Inc., Raymond Div.
Dallas Engineers, Inc., Coal-O-Matic Div.
Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc.

BOLTS

Duquesne Mine Supply Co.—"REDIPT"

BOLTS, NUTS, RIVETS

Oliver Iron & Steel Corp.

BOX-CAR LOADERS

Christian Engineers, J. D.
Hough Co., Frank G.
Hyster Co.—"HYSTER"
Lippmann Engineering Works
McNally Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Stephens-Adamson Mfg. Co.
Webster Mfg., Inc.

BRACES, TRACK & TIMBER

Templeton, Kenly & Co.—"SIMPLEX"

BRAKE BLOCKS

Manhattan Rubber Div., Raybestos Manhattan, Inc.

BRAKE BLOCKS, FRICTION, LINING, SHOES

American Brake Shoe Co.
Johns-Manville
Thermoid Co., Industrial Div.
Wagner Electric Corp.

BRAKE BLOCKS, LINING

Wellman Co., S. K.—"VELVETOUCH"

BRAKE BLOCKS, WOOD

Hammond Co., J. V.

BRAKE SHOES

Gibraltar Equip. & Mfg. Co.

BRAKE SHOES, METALLIC

American Brake Shoe Co.
Duquesne Mine Supply Co.
Flood City Brass & Elec. Co.
Helmick Foundry-Machine Co.

Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
National Mine Service Co.
West Virginia Armature Co.

BRAKES, LOCOMOTIVE

Ironton Engine Co.
Jeffrey Mfg. Co.
Mosebach Electric & Supply Co.
National Mine Service Co.

BRAKES, MAGNETIC

Clark Controller Co.
Cutler-Hammer, Inc.
Dings Magnetic Separator Co.
General Electric Co., Apparatus Sales Div.
Electric Controller & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Harnischfeger Corp.—"P&H"
Jeffrey Mfg. Co.
Stearns Magnetic, Inc.
Westinghouse Electric Corp.

BRAKES, MAGNETIC, EDDY CURRENT

Dynamatic Div., Eaton Mfg. Co.

BRAKES, TRUCK, & ACCESSORIES

Brake Engineering Co.
Wagner Electric Corp.

BRAKES, TRUCK, AIR

Eaton Mfg. Co., Axle Div.

BRAKES, TRUCK, AIR, HYDRAULIC, MECHANICAL, & ACCESSORIES

Timken Detroit Axle Div., Rockwell Spring & Axle Co.

BRAKES, FRICTION BANDS, EARTHMOVING EQUIPMENT—ARC COMPENSATORS FOR

Brake Engineering Co.

BRATTICE CLOTH

American Brattice Cloth Corp.—"ABC"
Daniels, Inc., C. R.—"DANDUX"
Dooley Bros.
du Pont de Nemours & Co., Inc., E. I.
Flocker & Co., John
Fulton Bag & Cotton Mills
Goodrich Co., B. F., Industrial Products Div.
National Mine Service Co.

BRATTICE STEEL DEMOUNTABLE

Tri-County Building Service

BREAKERS

WEMCO Div., Western Machinery Co.—"WEMCO HMS," "MOBIL-MILL"

BREAKERS, COAL, PICK

Cleveland Rock Drill Div., Westinghouse Air Brake Co.

BREAKERS, COAL, REVOLVING

Crusher Engineering Div., Poor & Co.
Gruendler Crusher & Pulverizer Co.
Heyl & Patterson, Inc.—"H & P BRADFORD BREAKER"
Jeffrey Mfg. Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.

BREAKERS, COAL TWO-STAGE

Gundlach Machine Co., T. J., Div. J. M. J. Industries, Inc.—"GUNDLACH"

BREAKERS, PAVING

Ingersoll-Rand Co.

BRUSH HOLDERS

Complete Reading Electric Co., Inc.
Flower Mfg. Co., D. B.—"FLOWER"
Ironton Engine Co.
Jeffrey Mfg. Co.
National Mine Service Co.
West Virginia Armature Co.

BRUSHES, CARBON

Complete Reading Electric Co., Inc.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Helwig Co.
Ironton Engine Co.
Keystone Carbon Co.
National Carbon Co., Div. Union Carbide & Carbon Corp.—"NATIONAL"
National Mine Service Co.
Ohio Carbon Co.
Pure Carbon Co.
Stackpole Carbon Co.
Spear Carbon Co.
Standard Carbon Co.
Superior Carbon Products, Inc.
Tracy Co., Bertrand P.
Westinghouse Electric Corp.
West Virginia Armature Co.

BUCKET TEETH

H. & L. Tooth Co.

BUCKETS, AERIAL TRAMWAY

Interstate Equipment Div., Yara Engineering Co.
Kanawha Mfg. Co.
Mahon Co., R. C.
Watt Car & Wheel Co.

BUCKETS, CLAMSHELL

Industrial Brownhoist Corp.
Wellman Engineering Co.

BUCKETS, CONVEYOR, ELEVATOR

American Steel Foundries—"WEARPACT"
Bonded Scale & Machine Co.
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Continental Gin Co., Industrial Div.
Enterprise Wheel & Car Corp.
Fairfield Engineering Co.
Fairmont Machinery Co.
Haiss Div., George, Pettibone-Mulliken Corp.
Helmick Foundry-Machine Co.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.—"LINK-BELT"
Magnetic Engineering & Mfg. Co.
Mahon Co., R. C.
Manhattan Rubber Div., Raybestos Manhattan, Inc.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Remaly Mfg. Co.
Sprout, Waldron & Co., Inc.
Transall, Inc.
Universal Engineering Co.
Watt Car & Wheel Co.
Webster Mfg., Inc.
Wilmot Engineering Co.

BUCKETS, DRAGLINE

Bucyrus-Erie Co.
Electric Steel Foundry
Haiss Div., George, Pettibone-Mulliken Corp.
Hendrix Mfg. Co.
Koehring Co.
Mahon Co., R. C.
Page Engineering Co.—"AUTOMATIC"
Pettibone-Mulliken Corp.
Sauerman Bros., Inc.
Schield Bantam Co.—"BANTAM"
Wellman Engineering Co.

BUCKETS, DRAGLINE—ARCHES, CHAINS, TEETH, ETC.

Bucyrus-Erie Co.
Electric Steel Foundry
Haiss Div., George, Pettibone-Mulliken Corp.
Hendrix Mfg. Co.
Mahon Co., R. C.
Orton Crane & Shovel Co.
Sauerman Bros., Inc.

BUCKETS, DRAGLINE—TEETH

H. & L. Tooth Co.

BUCKETS, ELEVATOR

Pioneer Engineering Works, Inc.
Savage Co., W. J.

BUFFERS, HYDRAULIC

Heyl & Patterson, Inc.

BUGDUSTERS, AUTOMATIC

Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.

BUILDINGS, PREFAB

Armco Drainage & Metal Products, Inc.
Arrowhead Steel Buildings, Inc.
Butler Mfg. Co.
Manu-Mine Research & Development Co.
Marietta Concrete Corp.—"PANELBILT"
Steel Built Construction Co.
Steelcraft Mfg. Co.—"STEELCRAFT"
Thomas Engineering & Construction Co.

BULLDOZER & GRADER BLADES

Allis-Chalmers Mfg. Co.
American Tractor Corp.—"TERRATRAC"
American Steel Foundries—"WEARPACT"
Austin-Western Co., Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Colorado Fuel & Iron Corp.—"CF&I"
Electric Steel Foundry Co.
International Harvester Co.
LeTourneau-Westinghouse Co.
Oliver Corp.—"OLIVER"

BULLDOZERS

Allis-Chalmers Mfg. Co., Tractor Div.
American Tractor Corp.—"TERRATRAC"
Austin Western Co., Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Baker Mfg. Co.
Caterpillar Tractor Co.
Clark Equipment Co., Construction Machinery Div.
Eimco Corp., The
Euclid Div., General Motors Corp.
Gar Wood Industries, Inc.
International Harvester Co.
LeTourneau-Westinghouse Co.—"TOURNATRACTOR"
Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc.

BUMPERS

Gibraltar Equipment & Mfg. Co.

BUMPERS, LOCOMOTIVE

Ironton Engine Co.
Jeffrey Mfg. Co.

BUMPERS, LOCOMOTIVE, MINE-CAR

Enterprise Wheel & Car Corp.
Helmick Foundry-Machine Co.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Thomas Engineering & Construction Co.
Webb Corp.
West Virginia Armature Co.

BUMPERS, MINE CAR

Phillips Div., Salem-Brosius, Inc.
Watt Car & Wheel Co.

BUMPERS, RUBBER

Continental Rubber Works

BUSHINGS, BRONZE

Tracy Co., Bertrand P.

BUSHINGS, ELECTRICAL

Delta-Star Electric Div., H. K. Porter Company, Inc., of Pittsburgh
Graybar Electric Co., Inc.

Johnson Bronze Co.
National Electric Products Co.
Ohio Brass Co.
Tracy Co., Bertrand P.
West Virginia Armature Co.

CABLE, ASBESTOS-VARNISHED, CAMBRIC

Rockbestos Products Corp.—"ROCKBESTOS A.V.C."

CABLE, BARE, STRANDED, FEEDER

Aluminum Co. of America
Anaconda Wire & Cable Co.
Flocker & Co., John
General Cable Corp.
Graybar Electric Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Roebling's Sons Co., John A., Sub. Colorado Fuel & Iron Corp.

CABLE, BOREHOLE

Simplex Wire & Cable Co.—"ANHYDREX"
United States Rubber Co., Electrical Wire & Cable Dept.

CABLE, COPPER & COPPERCLAD, BARE & STRANDED

Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"

CABLE, ELECTRICAL, WEATHERPROOF

Copperweld Steel Co., Wire & Cable Div.

CABLE, INSULATED, COMMUNICATION

Ansonia Wire & Cable Co.—"ANKOSEAL"

CABLE, INSULATED, CONTROL

Ansonia Wire & Cable Co.—"ANKOSEAL"

CABLE, INSULATED, DISTRIBUTION

Aluminum Company of America
American Steel & Wire Div., United States Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
Collyer Insulated Wire Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
Cornish Wire Co., Inc.
Delta-Star Electric Div., H. K. Porter Company, Inc., of Pittsburgh
Federal Telephone & Radio Co.
Flocker & Co., John
Flood City Brass & Electric Co.
General Cable Corp.
General Electric Co., Construction Materials Div.—"FLAMENOL," "SUPERCORONEL," "VERSATOL GEOPRENE," "GEOPRENE," "DELTABESTON," "SUPER CORONOL GEOPRENE"
Graybar Electric Co., Inc.
Joy Mfg. Co.
Kerite Co., The
Mosebach Electric & Supply Co.
National Electric Products Co.
National Mine Service Co.
Okonite Co.—"OKOLITE-OKOPRENE," "WATERTITE-HAZAPRENE," "KEYSTONE-HAZAPRENE"
Roebling's Sons Co., John A., Sub. Colorado Fuel & Iron Corp.
Rome Cable Corp.
Simplex Wire & Cable Co.—"ANHYDREX"
United States Rubber Co., Electrical Wire & Cable Dept.—"GRIZZLY"

CABLE, INSULATED, SUBMARINE

Ansonia Wire & Cable Co.—"ANKOSEAL"

CABLE, MINE FEEDER

Rome Cable Corp.

CABLE, MINING MACHINE

Rome Cable Corp.

CABLE, SHUTTLE-CAR

Rome Cable Corp.

CABLE, TELEPHONE

General Electric Co., Construction Materials Dept.—"FLAMENOL"
United States Rubber Co., Electrical Wire & Cable Dept.,—"LAYTEX"

CABLE, TRAILING

American Steel & Wire Div., United States Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
Collyer Insulated Wire Co.
Flocker & Co., John
Flood City Brass & Electric Co.
General Cable Corp.
General Electric Co., Construction Materials Div.
Joy Mfg. Co.
National Mine Service Co.
Okonite Co.—"HAZACORD"
Roebling's Sons Co., John A., Sub. Colorado Fuel & Iron Corp.
Rome Cable Corp.
Simplex Wire & Cable Co.—"TIREX"
U. S. Rubber Co., Electrical Wire & Cable Dept.—"ROYAL," "ROYAL GOLD"

CABLE ACCESSORIES, HIGH-VOLTAGE

G & W Electric Specialty Co.

CABLE CLAMPS

Trico Fuse Mfg. Co.—"KLIPLOK"

CABLE CONNECTORS, ELECTRICAL

Anaconda Wire & Cable Co.
Anderson Mfg. Co., Albert & J. M.
Burndy Engineering Co.—"HYLUGS," "HYLINKS"
Elreco Corp.
Erico Products, Inc.—"CADWELD"
Flocker & Co., John
Flood City Brass & Elec. Co.
General Cable Corp.
Graybar Electric Co., Inc.
Joy Mfg. Co.—"QUIKLOC," "MAGLOC"
Mosebach Electric & Supply Co.
National Electric Products Co.
National Mine Service Co.
Ohio Brass Co.
Victor Equipment Co.
West Virginia Armature Co.

CABLE REELS, LOCOMOTIVE

General Electric Co., Apparatus Sales Div.
Ironton Engine Co.

CABLE REELS, LOCOMOTIVE, MACHINE

Flocker & Co., John
Goodman Mfg. Co.
Industrial Machine & Elec. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
National Mine Service Co.
West Virginia Armature Co.

CABLE REELS, SHOTFIRING

Hammond Co., J. V.

CABLE SHOCK ABSORBERS

Elreco Corp.
Mosebach Electric & Supply Co.

CABLE SPLICERS

Ensign Electric & Mfg. Co.
West Virginia Armature Co.

CABLE SPLICERS, VULCANIZERS

American Mine Door Co.—"CANTON"
Flood City Brass & Electric Co.
Joy Mfg. Co.
Mine Safety Appliances Co.—"VELOCITY POWER"
Mosebach Electric & Supply Co.

CABLE SUPPORTS

Delta-Star Electric Div., H. K. Porter Co., Inc., of Pittsburgh

CAGERS, CAGING EQUIPMENT

Connellsville Mfg. & Mine Supply Co.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Nolan Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

CAGES

Connellsville Mfg. & Mine Supply Co.
Gibraltar Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Holmes & Bros., Inc., Robert
Kanawha Mfg. Co.
Mayo Tunnel & Mine Equipment Co.
Nolan Co.
Nordberg Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Vulcan Iron Works

CAGES, ELEVATOR-TYPE

Connellsville Mfg. & Mine Supply Co.

CALCIUM CHLORIDE

American Chemsol Co.
Columbia-Southern Chemical Co., Sub. Pittsburgh Plate Glass Co.
Dow Chemical Co.—"DOWFLAKE," "PELADOW"
duPont de Nemours & Co., Inc., E. I.
Fisher Scientific Co.
Fuel Process Co.
Michigan Alkali Div., Wyandotte Chemicals Corp.
Solvay Sales Div., Allied Chemical & Dye Corp.

CAPACITORS

Federal Telephone & Radio Co.
Graybar Electric Co., Inc.
Westinghouse Electric Corp.

CAP-LAMP CHARGERS

Mine Safety Appliances Co.
National Mine Service Co.—"KOEHLER"

CAP-LAMP RACKS

Mine Safety Appliances Co.
National Mine Service Co.—"WHEAT"

CAP LAMPS

General Electric Co., Lamp Division
Mine Safety Appliances Co.—"EDISON"
National Mine Service Co.—"WHEAT"

CAR DUMPERS, R. R., ROTARY

Heyl & Patterson, Inc.
Wellman Engineering Co.

CAR HAULS

Wellman Engineering Co.

CAR HAULS, SPOTTERS, MINE

Christian Engineers, J. D.
Connellsville Mfg. & Mine Supply Co.
Davis Co., Nelson L.
Flood City Brass & Elec. Co.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Nolan Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Sanford-Day Iron Works, Inc.—"BROWNIE"
Stephens-Adamson Mfg. Co.
Vulcan Iron Works
Webster Mfg., Inc.
Wilmot Engineering Co.

CAR HOLDS, CHAIN

Duquesne Mine Supply Co.

CAR MOVERS

Advance Car Mover Co., Inc.—"BADGER-LINE"
Gibraltar Equipment & Mfg. Co.

CAR MOVERS, PULLERS, R. R.

Austin-Western Co., Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Bartlett, C. O., & Snow Co.
Christian Engineers, J. D.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Hough Co., Frank G.
Jeffrey Mfg. Co.
Jones Foundry & Machine Co., W. A.
Joy Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Stephens-Adamson Mfg. Co.
Webster Mfg., Inc.
Wellman Engineering Co.
Whiting Corp.—"TRACKMOBILE"

CAR RETARDERS, R. R.

Fairmont Machinery Co.
Heyl & Patterson, Inc.
Holmes Bros., Inc., Robert
Industrial Machine & Electric Co.
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Union Switch & Signal, Div. Westinghouse Air Brake Co.
Webster Mfg., Inc.
Wellman Engineering Co.

CAR SHAKERS, R. R.

Allis-Chalmers Mfg. Co.
Hewitt-Robins, Inc.—"SHAKEOUT"
Link-Belt Co.—"LINK-BELT"
Neff & Fry Co.—"NATIONAL CAR SHAKER"
Simplicity Engineering Co.
Webster Mfg., Inc.

CAR SPOTTERS, MINE

Stamler Co., W. R.

CAR STOPS

Duquesne Mine Supply Co.

CAR TRANSFERS

American Mine Door Co.

CAR UNLOADERS, R. R.

Barber-Greene Co.
Christian Engineers, J. D.
Fairfield Engineering Co.
Haiss Div., George, Pettibone Mulliken Corp.
Hewitt-Robins, Inc.—"SHAKEOUT"
Heyl & Patterson, Inc.—"KINNEY"
Hough Co., Frank G.
Jeffrey Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Pettibone Mulliken Corp.
Stephens-Adamson Co.
Webster Mfg., Inc.
Wellman Engineering Co.

CAR THAWERS

Hauck Mfg. Co.

CARBON BLACK

Fisher Scientific Co.
Vanderbilt Co., R. T.—"M-1 BLACK"

CARRIERS, MINE EQUIPMENT

Card, C. S., Iron Works Co.
Fletcher & Co., J. H.
Joy Mfg. Co.
Phillips Div., Salem-Brosius, Inc.

CARS, RAIL, AIR-DUMP

Baldwin-Lima-Hamilton Corp.

CARS, RAIL, MINE

ACF Industries, Inc.
Bethlehem Steel Co.
Card, C. S., Iron Works Co.
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Hockensmith Corp.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Kersey Mfg. Co., Inc.
Mahon Co., R. C.
Mayo Tunnel & Mine Equipment Co.
Morse Bros. Machinery Co.
Phillips Div., Salem-Brosius, Inc.
Sanford-Day Iron Works, Inc.
United States Steel Corp.
Watt Car & Wheel Co.
Webb Corp.

CARS, RAIL, MAN-TRIP

Card, C. S., Iron Works Co.
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Holmes & Bros., Inc., Robert
Irwin Foundry & Mine Car Co.
Kersey Mfg. Co., Inc.
Lee-Norse Co.—"PORTAL BUS"
Mahon Co., R. C.
Sanford-Day Iron Works, Inc.
Watt Car & Wheel Co.

CARS, RAIL, PERSONNEL, SELF-PROPELLED

Atlas Car & Mfg. Co.
Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.
Lee-Norse Co.—"PORTAL BUS"
Mahon Co., R. C.

CARS, RAIL, SUPPLY

ACF Industries, Inc.
Bethlehem Steel Co.
Card, C. S., Iron Works Co.
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Kersey Mfg. Co., Inc.
Watt Car & Wheel Co.

CARS, RAIL, SUPPLY, SELF-PROPELLED

Atlas Car & Mfg. Co.
Kanawha Mfg. Co.
Klocckner-Humbaldt-Deutz AG, c/o Diesel Energy Corp.
Lee-Norse Co.—"JITNEY"

CARS, RAIL, TOOL & REPAIR, SELF-PROPELLED

Atlas Car & Mfg. Co.
Kanawha Mfg. Co.
Lee-Norse Co.—"JITNEY"

CARS, RUBBER-TIRED, COAL, SELF-PROPELLED

Joy Mfg. Co.
Kanawha Mfg. Co.

CARS, RUBBER-TIRED, MEN & SUPPLIES SELF-PROPELLED

Joy Mfg. Co.
Kanawha Mfg. Co.
Kersey Mfg. Co.
Lee-Norse Co.—"JITNEY"

CARS, RUBBER-TIRED TRAILING, COAL

Joy Mfg. Co.
Kanawha Mfg. Co.
Kersey Mfg. Co., Inc.

CARS, RUBBER-TIRED TRAILING, MEN & SUPPLIES

Joy Mfg. Co.
Kanawha Mfg. Co.
Kersey Mfg. Co., Inc.
Lee-Norse Co.—"JITNEY"

CARS, SHUTTLE

ACF Industries, Inc.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Mahon Co., R. C.
Morse Bros. Machinery Co.

CARS, SHUTTLE, CRAWLER TYPE

General Electric Co., Apparatus Sales Div.

CARS, SHUTTLE, DIESEL

Joy Mfg. Co.

CARS, SURGE

Irwin Foundry & Mine Car Co.
Joy Mfg. Co.
Lee-Norse Co.

CARTRIDGES, CYLINDRICAL, BALL-BEARING

Fafnir Bearing Co.

CARTRIDGES, FLANGE, BALL-BEARING

Fafnir Bearing Co.

CAUSTIC SODA

American Chemsol Co.
Columbia-Southern Chemical Co., Sub. Pittsburgh Plate Glass Co.
duPont de Nemours & Co., Inc.
Dow Chemical Co.
Fisher Scientific Co.
Michigan Alkali Div., Wyandotte Chemicals Corp.

CEMENT, HIGH-TEMPERATURE

Mexico Refractories Co.—"HILOSET," "BONDSET," "MEX-LOX"

CEMENT SPRAYERS

Construction Machinery Co.
Manu-Mine Research & Development Co.

CENTRIFUGALS

Centrifugal & Mechanical Industries, Inc.—"C-M-I"

CHAIN, CONVEYOR & ELEVATOR

American Brake Shoe Co.
American Conveyor Co.
Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.
Chain Belt Co.—"REX," "CHABELCO"
Christian Engineers, J. D.
Clarkson Mfg. Co.—"REDBIRD"
Continental Gin Co., Industrial Div.
Diamond Chain Co., Inc.
Fairmont Machinery Co.
Haiss Div., George, Pettibone Milliken Corp.
Herold Mfg. Co.
Heyl & Patterson, Inc.
Holmes & Bros. Inc., Robert
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel Co.
Link-Belt Co.—"LINK-BELT"
Long Co.—"SUPERFLITE"
McNally Pittsburg Mfg. Corp.
Morse Chain Co., a Borg-Warner Industry
National Mine Service Co.
Republic Steel Corp.—"REPUBLIC"
Savage Co., W. J.
Stephens-Adamson Mfg. Co.
Taylor-Wharton Iron & Steel Co.
Transall, Inc.
Watt Car & Wheel Co.
Webster Mfg., Inc.
Whitney Chain Co.
Wilmot Engineering Co.

CHAIN FITTINGS

American Hoist & Derrick Co.

CHAIN, POWER-TRANSMISSION

Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.
Browning Mfg. Co.
Chain Belt Co.—"REX," "CHABELCO"
Christian Engineers, J. D.
Continental Gin Co., Industrial Div.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.

Kremser & Sons, Inc., Frank A.
Link-Belt Co.—"LINK-BELT"
Morse Chain Co., a Borg-Warner Industry
National Mine Service Co.
Savage Co., W. J.
Stephens-Adamson Mfg. Co.
Tracy Co., Bertrand P.
Transall, Inc.
Webster Mfg., Inc.
Whitney Chain Co.

CHAIN, WELDED
Republic Steel Corp.—"REPUBLIC"

CHAIN-HOUSE EQUIPMENT
National Mine Service Co.

CHUTES
Lippmann Engineering Works

CHUTES, DIVERSION, COAL-LOADING
Christian Engineers, J. D.
Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Mahon Co., R. C.
McNally Pittsburg Mfg. Corp.
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Savage Co., W. J.
Thomas Engineering & Construction Co.
Webster Mfg., Inc.
Wilmot Engineering Co.

CIRCUIT BREAKERS
Allis-Chalmers Mfg. Co.
Cutler-Hammer, Inc.
Dooley Bros.
General Electric Co., Appar. Sales Div.
General Electric Co., Trumbull Components and Distribution Assemblies Dep'ts.
Graybar Electric Co., Inc.
Heineman Elec. Co.
I-T-E Circuit Breaker Co.
Joy Mfg. Co.
National Mine Service Co.
Westinghouse Electric Corp.

CIRCUIT INTERRUPTERS, TRAILING CABLE
Ohio Brass Co.—"MAGNA-TRIP"

CLAMPS, FUSE AND TEST
Trico Fuse Mfg. Co.—"KLIPLOK"

CLAMPS, TROLLEY
Elreco Corp.

CLAMSHELLS, CRAWLER & RUBBER-TIRED
Thew Shovel Co.

CLASSIFIERS, HYDRAULIC
Deister Concentrator Co.—"CONCENCO"
Deister Machine Co.
Denver Equipment Co.
Dorr-Oliver Incorporated
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
WEMCO Div., Western Machinery Co.—"WEMCO"
Wilmot Engineering Co.

CLASSIFIERS, MECHANICAL
Christian Engineers, J. D.
Colorado Iron Works
Combustion Engineering, Inc., Raymond Div.
Daniels Co., Contractors, Inc.
Denver Equipment Co.
Dorr-Oliver Incorporated
Hardinge Co., Inc.
Jeffrey Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Mine & Smelter Supply Co., March Mill Div.—"AKINS"
Morse Bros. Machinery Co.
Straub Mfg. Co.
Sturtevant Mill Co.

CLASSIFIERS, SPIRAL
WEMCO Div., Western Machinery Co.—"WEMCO"

CLIPS, WIRE ROPE
American Hoist & Derrick Co.
Macwhyte Company
Upson-Walton Co.

CLUTCH COUPLINGS
Marland One-Way Clutch Co.

CLUTCH FACINGS, LININGS
American Brake Shoe Co.
Johns-Manville
Thermoid Co., Industrial Div.
Tracy Co., Bertrand P.
Wellman Co., S. K.—"VELVETOUCH"

CLUTCHES, AUTOMATIC
Centric Clutch Co.

CLUTCHES, CAM
Morse Chain Co.

CLUTCHES, CENTRIFUGAL
Centric Clutch Co.

CLUTCHES, COUPLING
Centric Clutch Co.

CLUTCHES, DRIVE-WHEEL-FRICTION
Lee-Norse Co.—"LEE-NORSE"

CLUTCHES, ELECTRIC MOTOR
Centric Clutch Co.

CLUTCHES, ENGINE
Centric Clutch Co.

CLUTCHES, FREE-WHEELING
Marland One-Way Clutch Co.

CLUTCHES, FRICTION
Centric Clutch Co.
Cooper Split Roller Bearing Co.
Dodge Mfg. Corp.—"ROLLER GRIP," "DIAMOND D"
Jeffrey Mfg. Co.
Link-Belt Co. —"LINK-BELT"
Morse Chain Co., A Borg-Warner Industry—"PULLMORE"
Twin Disc Clutch Co.
Webster Mfg., Inc.
Zurn Mfg. Co., J. Z., American Flexible Coupling Div.—"SYNCHROGEAR"

CLUTCHES, JAW
Chain Belt Co.—"REX"

CLUTCHES, MAGNETIC
Cutler-Hammer Inc.
Stearns Magnetic Inc.
Twin Disc Clutch Co.

CLUTCHES, OVER-CENTER
Morse Chain Co.

CLUTCHES, OVERLOAD RELEASING
Centric Clutch Co.

CLUTCHES, PULLEY
Centric Clutch Co.

CLUTCHES, ROTARY
Centric Clutch Co.

CLUTCHES, SHEAVE
Centric Clutch Co.

CLUTCHES, V-BELT
Centric Clutch Co.

COAL-ANALYSIS LABORATORIES
Commercial Testing & Engrg. Co.
Fisher Scientific Co.
Holmes & Bros., Inc., Robert
Manu-Mine Research & Development Co.
Warner Laboratories

COAL BREAKER, AIR
Cardox Corp.
Olin Mathieson Chemical Corp., Explosives Div.—"ARMSTRONG"

COAL BREAKERS, CARBON-DIOXIDE
Cardox Corp.

COAL BREAKERS, CHEMICAL
Cardox Corp.
duPont de Nemours & Co., Inc., E. I.
Jeffrey Mfg. Co.

COAL PLANNERS
Westfalia Lunen, c/o Mining Progress, Inc.

COATINGS, MINE ROOF, RIGS
American Chemsol Co.—"CHEMSKIN"
Magic Chemical Co.

COATINGS, PERMANENT STOPPINGS
American Chemsol Co.—"CHEMSTOP"

COATINGS, PIPE, CAST
U. S. Pipe & Foundry Co.

COATINGS, PROTECTIVE, RUST-PREVENTIVE
American Chemsol Co.—"CHEMPENT"
Carey Mfg. Co.,—"CAREY CLAD," "NOAH'S PITCH," "ENAMELCLAD," "FLEXTOP," "FLAT-TOPP," "FIBER-FLEX," ETC.
Dixon Crucible Co., Joseph
Dow Corning Corp.
duPont de Nemours & Co., Inc., E. I.
Esso Standard Oil Co.—"RUST-BAN"
Goodall Rubber Co.
Insul-Mastic Corp. of America
Johns-Manville—"INSULKOTE"
Magic Chemical Co.
National Mine Service Co.
Neff & Fry Co.
Osmose Wood Preserving Co.
Pittsburgh Plate Glass Co.—"PITTSBURGH IRONHIDE METAL"
Rust-Oleum Corp.
Shell Oil Co.
Sinclair Refining Co.
Socony-Mobil Oil Co.—"SOVACOATS"
United States Rubber Co., Mechanical Goods Div.
Valvoline Oil Co., Div. of Ashland Oil & Refining Co.—"VALVOLINE"
Warren Refining & Chemical Co.—"WARCO"

COATINGS, ROOF
Warren Refining & Chemical Co.—"STORM KING," "STORM KING ALUMINUM," "STORM KING PLUS"

COATINGS, WATER-SEALING
Manu-Mine Research & Development Co.

COIL TESTERS
Complete Reading Electric Co., Inc.
Flood City Brass & Elec. Co.
Martindale Electric Co.

COILS, ARMATURE, FIELD, ETC.
Flood City Brass & Electric Co.
Hannon & Sons, F. R.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Mining Machine Parts, Inc.
National Electric Coil Co.
National Mine Service Co.
Pennsylvania Electric Coil Corp.
West Virginia Armature Co.

COILS, DEMAGNETIZING
Dings Magnetic Separator Co.

COMMUNICATION SYSTEMS
Femco, Inc.—"TROLLEYPHONE," "AUDIPHONE"

COMMUNICATIONS, INDUCTIVE-CARRIER
Union Switch & Signal Div., Westinghouse Air Brake Co.

COMMUNICATORS, INTEROFFICE & PLANT
Federal Telephone & Radio Co.
Femco, Inc.
Motorola Communications & Electronics, Inc.
National Mine Service Co.
Talk-A-Phone

COMMUTATORS
West Virginia Armature Co.

COMMUTATOR TOOLS
Holub Industries
Ideal Industries Inc.
Martindale Electric Co.

COMPOUNDS, COAL-TREATING
American Chemsol Co.
Commercial Testing & Engrg. Co.
Esso Standard Oil Co.—"COAL SPRAY OIL"
Johnson March Corp.
Magic Chemical Co.

COMPOUNDS, PIPE-JOINT
Keystone Lubricating Co.

COMPOUNDS, SPRAY-WATER ADDITIVES
Dow Chemical Co.—"SEPARAN"
Johnson March Corp.
Magic Chemical Co.
Michigan Alkali Div., Wyandotte Chemicals Corp.

CONCRETE SPRAYING
Gunite Concrete & Construction Co.
Manu-Mine Research & Development Co.
Reintjes Co., George P.

CONCRETE SPRAYING EQUIPMENT
Construction Machinery Co.

CONDUIT, ELECTRICAL
Flexaust Co.—"PLICA"
General Electric Co., Construction Materials Div.
Graybar Electric Co., Inc.
Johns-Manville—"TRANSITE," "KORDUCT"
Mosebach Electric & Supply Co.
National Electric Products Co.—"SHERARDUCT, XDUCT, XDUCT JR"
National Mine Service Co.
Republic Steel Corp.—"REPUBLIC ELECTRUNITE"
Rome Cable Corp.
Triangle Conduit & Cable Co.
Younstown Sheet & Tube Co.—"BUCKEYE"

CONNECTORS, COMPRESSION, CABLE
Burndy Engineering Co.,—"HYLUGS, HYLINKS"

CONNECTORS, WIRE
Johns-Manville, Dutch Brand Div.

CONTACTORS, ELECTRICAL
Allen-Bradley Co.
Allis-Chalmers Mfg. Co.
Arrow Hart & Hegeman Electric Co.
Clark Controller Co.
Cutler-Hammer, Inc.
Dooley Bros.
General Electric Co., Apparatus Sales Div.
National Mine Service Co.
Spear Carbon Co.
Tracy Co., Bertrand P.
Welch Electric Co.
Westinghouse Electric Corp.

CONTAINERS, RUBBER COLLAPSIBLE
United States Rubber Co., Mechanical Goods Div.

CONTINUOUS MINERS
Clarkson Mfg. Co.—"MARIETTA"
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Lee-Norse Co.—"LEE-NORSE MINER"
Cleveland Rock Drill Div., Westinghouse Air Brake Co.

CONTRACTORS, BUILDING, ERECTING
Daniels Co., Contractors, Inc.
Dravo Corp.
Fairmont Machinery Co.
Industrial Engrg. & Construction Co.
Mahon Co., R. C.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Thomas Engineering & Construction Co.
Vincennes Steel Corp.

CONTRACTORS, CORE-DRILLING
Longyear Co., E. J.

CONTRACTORS, DRILLING
Hoffman Brothers Drilling Co.
Joy Mfg. Co.
Longyear Co. E. J.
Manu-Mine Research & Development Co.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sprague & Henwood, Inc.

CONTRACTORS, ELECTRICAL CONSTRUCTION
National Mine Service Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
West Virginia Electric Corp.

CONTRACTORS, GROUTING
Dravo Corp.
Manu-Mine Research & Development Co.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sprague & Henwood, Inc.

CONTRACTORS, SHAFT-DRILLING
Pennsylvania Drilling Co.

CONTRACTORS, SHAFT & SLOPE
Dravo Corp.
Johnson Co., R. G.
Manu-Mine Research & Development Co.

CONTROLLERS, ELECTRIC
Allen-Bradley Co.
Allis-Chalmers Mfg. Co.
Arrow Hart & Hegeman Electric Co.
Bristol Co.—"BRISTOL'S"
Cash Co., A. W.
Clark Controller Co.
Electric Controller & Mfg. Co.
Ensign Electric & Mfg. Co.
Fischer & Porter Co.
Flood City Brass & Electric Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Graybar Electric Co., Inc.
Ironton Engine Co.
Jeffrey Mfg. Co.
Square D Co.

CONTROLLERS, ELECTRIC AND PARTS
Tracy Co., Bertrand P.

CONTROLLERS, ELECTRIC TRACK SWITCH AND DERAIL
Cheatham Electric Switching Device Co.

CONTROLLERS, ELECTRONIC
Dynamatic Div. Eaton Mfg. Co.

CONTROLLERS, HYDRAULIC
Cash Co., A. W.

CONTROLLERS, LOCOMOTIVE
National Mine Service Co.—N. M. S.

CONTROLLERS, PNEUMATIC
Cash Co., A. W.

CONTROLS AND TRANSMISSION
Berry Div., Oliver Iron & Steel Corp.—"BERRY"

CONTROLS, INDUCTIVE CARRIER
Union Switch & Signal Div., Westinghouse Air Brake Co.

CONTROLS, REMOTE
Femco, Inc.

CONTROLS, SAND-FLOTATION CONES
Fairmont Machinery Co.

CONVEYOR BELTING
American Conveyor Co.
Barber-Greene Co.
Bonded Scale & Machine Co.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co.
Cincinnati Rubber Mfg. Co.
Colorado Fuel & Iron Corp.— "WISSCO"
Continental Gin Co., Industrial Div.
Fletcher & Co., J. H.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co., Inc.
Haiss Div., George, Pettibone Milliken Co.
Hamilton Rubber Mfg. Corp.
Hewitt-Robins Inc.,—"AJAX," CONSERVO," "HEWLITE," "MALTESE CROSS," "MONARCH"
Iowa Mfg. Co.
Joy Mfg. Co.
Kremser & Sons, Inc. Frank A.
Link-Belt Co.—"LINK BELT"
Manhattan Rubber Div., Raybestos-Manhattan, Inc.
New York Belting & Packing Co.—"GREAT SEAL," "INDESTRUCTIBLE," "NYBTEX-NYLON"
National Mine Service Co.
Pioneer Engineering Works, Inc.
Quaker Rubber Corp. Div. H. K. Porter Company, Inc., of Pittsburgh
Quaker Pioneer Rubber Mills
Republic Rubber Div., Lee Rubber & Tire Corp.
Savage Co., W. J.
Scandinavia Belting Co.
Stephens-Adamson Mfg. Co.
Thermoid Co,, Industrial Div.
Transall, Inc.
United States Rubber Co., Mechanical Goods Div.
Webb Corp .
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"WISSCO"

CONVEYOR BELTING CLEANERS
American Conveyor Co.
Bonded Scale & Machine Co.
Christian Engineers, J. D.
Continental Gin Co., Industrial Div.
Davis Co., Nelson L.
Goodrich Co., B. F. Industrial Products Div.
Hewitt-Robins Inc.—"AJAX"
Joy Mfg. Co.
Link-Belt Co.,—"LINK BELT"
Magic Chemical Co.
Marsh Engineering Co., E. F.
McNally Pittsburgh Mfg. Corp.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.
United States Rubber Co., Mechanical Goods Div.

CONVEYOR BELTING FASTENERS

American Conveyor Co.
Armstrong-Bray & Co.—"PLATEGRIP"
Bonded Scale & Machine Co.
Continental Gin Co., Industrial Div.
Crescent Belt Fastener Co.
Flexible Steel Lacing Co.—"FLEXCO," "ALLIGATOR"
Goodman Mfg. Co.
Goodrich Co., B. F., Industrial Products Div.
Haiss Div., George, Pettibone Mulliken Co.
Iowa Mfg. Co.
Kremser & Sons, Inc., Frank A.
National Mine Service Co.—"HAYDEN"
Talcott, Inc., W. O. & M. W.—"TALCOTT"
United States Rubber Co., Mechanical Goods Div.

CONVEYOR BELTING REPAIR

Armstrong-Bray & Co.—"PLATEGRIP"
Flexible Steel Lacing Co.—"REMA"
General Splice Corp.—"MINET BELT SPLICE"
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co., Inc.
Industrial Rubber Products Co.
Linatex Corp. of America
Magic Chemical Co.
Reid Belt & Rubber Co.
Talcott, Inc. W. O. & M. W.—"TALCOTT-ACME"
United States Rubber Co., Mechanical Goods Div.
W. Va. Belt & Cable Repairs, Inc.

CONVEYOR BELTING VULCANIZERS

Heintz Mfg. Co.

CONVEYOR COVERS

Armco Drainage & Metal Prod., Inc.

CONVEYOR DRIVES—LOADERS, CONTINUOUS MINERS

Cooke-Wilson Elec. Supply Co.

CONVEYOR IDLERS

American Conveyor Co.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Continental Gin Co., Industrial Div.
Fletcher & Co., J. H.
Haiss Div., George, Pettibone Mulliken Co.
Hewitt-Robins, Inc.—"HEWITT-ROBINS"
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.—"LIMBEROLLER"
Kanawha Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.—"LINK-BELT"
Lippmann Engineering Works
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Pettibone Mulliken Corp.
Pioneer Engineering Works, Inc.
Silver Engineering Works, Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Universal Engineering Co.
Webb Corp.
Webster Mfg., Inc.
Woods Sons Co., T. B.

CONVEYOR LOADING CHECKS

Daly Ticket Co.—"DALY'S"

CONVEYOR WEIGHERS

B I F Industries, Inc., Builders-Providence Div.—"CONVEYOFLO"
Kanawha Mfg. Co.
Merrick Scale Mfg. Co.—"WEIGHTOMETER"
Schaffer Poidometer Co.
Transall, Inc.

CONVEYORS, APRON

American Conveyor Co.
Bartlett, C. O., & Snow Co.
Bodinson Mfg. Co.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Continental Gin Co., Industrial Div.
Davis Co., Nelson L.
Fairfield Engineering Co.
Fairmont Machinery Co.
Haiss Div., George, Pettibone Mulliken Co.
Herold Mfg. Co.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co.—"LINK-BELT"
Lippmann Engineering Works
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Taylor-Wharton Iron & Steel Co.
Transall, Inc.
Universal Engineering Co.
Webb Corp.
Webster Mfg., Inc.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"WISSCO"

CONVEYORS, ASH

United Conveyor Corp.

CONVEYORS, BELT

American Conveyor Co.—"CON-VAY-IT," "STOKER-VEYOR"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Barber-Greene Co.
Bartlett, C. O., & Snow Co.
Baughman Mfg. Co.
Bonded Scale & Machine Co.—"BONDED"
Boston Woven Hose & Rubber Co.
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Compton, Inc.
Continental Gin Co., Industrial Div.
Davis Co., Nelson L.
Fairfield Engineering Co.
Fletcher & Co., J. H.
Goodall Rubber Co.
Goodman Mfg. Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co., Inc.
Haiss Div., George, Pettibone Mulliken Co.
Herold Mfg. Co.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Iowa Mfg. Co.
Industrial Engrg. & Construction Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.—"LINK-BELT"
Lippmann Engineering Works
Magnetic Engineering & Mfg. Co.
Marsh Engineering Co., E. F.—"MARCO TUBULAR FRAME"
Mayo Tunnel & Mine Equipment Co.
McNally Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Pioneer Engineering Works, Inc.
Prins & Associates, K.
Ridge Equipment Co.
Silver Engineering Works, Inc.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall, Inc.
United States Rubber Co., Mechanical Goods Div.
Universal Engineering Co.
Webb Corp.
Webster Mfg., Inc.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"WISSCO"

CONVEYORS, BELT, EXTENSIBLE

Christian Engineers, J. D.
Continental Gin Co., Industrial Div.
Goodyear Tire & Rubber Co., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Marsh Engineering Co., E. F.
Prins & Associates, K.
United States Rubber Co., Mechanical Goods Div.
Universal Engineering Co.

CONVEYORS, BELT TRIPPERS

Bartlett, C. O., & Snow Co.
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Continental Gin Co., Industrial Div.
Fairfield Engineering Co.
Hewitt-Robins, Inc.—"AJAX," "MON-ARCH," "DUST SEAL"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Magnetic Engineering & Mfg. Co.
McNally Pittsburg Mfg. Corp.
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Universal Engineering Co.
Webster Mfg., Inc.

CONVEYORS, BUCKET

American Conveyor Co.
Baughman Mfg. Co.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Continental Gin Co., Industrial Div.
Davis Co., Nelson L.
Fairmont Machinery Co.
Goodyear Tire & Rubber Co., Inc.
Haiss Div., George, Pettibone-Mulliken Co.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engr. Corp.
Link-Belt Co.—"LINK-BELT"
Lippmann Engineering Works
Magnetic Engineering & Mfg. Co.
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Prins & Associates, K.
Ridge Equipment Co.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall, Inc.
Universal Engineering Co.
Webb Corp.
Webster Mfg., Inc.
Wilmot Engineering Co.

CONVEYORS, BUCKET, CHAIN

Gibraltar Equipment & Mfg. Co.

CONVEYORS, CHAIN & FLIGHT

American Conveyor Co.—"FLIGHT-VEYOR"
American Well Works
Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Clarkson Mfg. Co.—"REDBIRD"
Compton, Inc.

Continental Gin Co., Industrial Div.
Davis Co., Nelson L.
Fairfield Engineering Co.
Fairmont Machinery Co.
Gibraltar Equipment & Mfg. Co.
Haiss Div., George, Pettibone-Mulliken Corp.
Herold Mfg. Co.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Industrial Engrg. & Construction Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Lippmann Engineering Works
Long Co.
Magnetic Engineering & Mfg. Co.
McNally Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Taylor-Wharton Iron & Steel Co.
Transall, Inc.
Universal Engineering Co.
Vulcan Iron Works
Watt Car & Wheel Co.
Webb Corp.
Webster Mfg., Inc.
Wilmot Engineering Co.

CONVEYORS, ELEVATING

American Conveyor Co.
Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Continental Gin Co., Industrial Div.
Davis Co., Nelson L.
Dayton Automatic Stoker Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
Gibraltar Equipment & Mfg. Co.
Goodyear Tire & Rubber Co., Inc.
Haiss Div., George, Pettibone-Mulliken Corp.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Link-Belt Co.—"LINK-BELT"
Lippmann Engineering Works
Long Co.
Magnetic Engineering & Mfg. Co.
McNally Pittsburg Mfg. Corp.
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.
United States Rubber Co., Mechanical Goods Div.
Universal Engineering Co.
Webb Corp.
Webster Mfg., Inc.
Wilmot Engineering Co.

CONVEYORS, MINE BRIDGE

Joy Mfg. Co.
Long Co.—"PIGGYBACK"

CONVEYORS, PNEUMATIC

Convair, Inc.
U. S. Hoffman Machinery Corp.
United Conveyor Corp.

CONVEYORS, PORTABLE

Barber-Greene Co.

CONVEYORS, ROPE-AND-BUTTON

Fairmont Machinery Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Webb Corp.

CONVEYORS, SCREW

Bartlett, C. O., & Snow Co.
Baughman Mfg. Co.
Canton Stoker Corp.—"FLO-TUBE"
Construction Machinery Co.
Continental Gin Co., Industrial Div.
Dallas Engineers, Inc., Cool-O-Matic Div.
Dayton Stoker Co.
Fairfield Engineering Co.
Haiss Div., George, Pettibone-Mulliken Corp.
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Lippmann Engineering Works
McNally Pittsburg Mfg. Corp.
Pioneer Engineering Works, Inc.
Roberts & Schaefer Co., Sub. of Thompson-Starrett Co., Inc.
Sprout, Waldron & Co., Inc.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall, Inc.
Webb Corp.
Webster Mfg., Inc.
Western Machinery Co.

CONVEYORS, SCREW, MANGANESE, STEEL

Christian Engineers, J. D.

CONVEYORS, SELF-LOADING

Goodman Mfg. Co.—"DUCKBILL LOADING HEAD"
Herold Mfg. Co.

CONVEYORS, SHAKING

Goodman Mfg. Co.
Herold Mfg. Co.
Joy Mfg. Co.

CONVEYORS, SHAKING, VIBRATING

Hewitt-Robins, Inc.—"GYREX," "HYDREX," "ROCKERMOUNT," "SPRINGMOUNT"
Heyl & Patterson, Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Lecco Machinery & Engineering Co.—"LECCO VIB"
Link-Belt Co.—"LINK-BELT"
Lippmann Engineering Works.
Prins & Associates, K.
Ridge Equipment Co.
Simplicity Engineering Co.—"SIMPLICITY OS-A-VEYOR"
Stephens-Adamson Mfg. Co.
Syntron Co.

CONVEYORS, SPIRAL-LOWERING

Christian Engineers, J. D.
Continental Gin Co., Industrial Div.
Holmes & Bros., Inc., Robert
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Lippmann Engineering Works
McNally Pittsburg Mfg. Corp.

CORDS, DRILL

Cornish Wire Co., Inc.
Flocker & Co., John
Flood City Brass & Electric Co.
General Cable Corp.
Graybar Electric Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Simplex Wire & Cable Co.
United States Rubber Co., Electrical Wire & Cable Dept.

CORDS, PORTABLE, ELECTRIC

United States Rubber Co., Electrical Wire & Cable Dept.—"ROYAL"

CORDS, SHOTFIRING

Cornish Wire Co., Inc.
Flocker & Co., John
General Cable Corp.
General Electric Co., Construction Materials Div.
King Powder Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Rome Cable Corp.
Simplex Wire & Cable Co.
United States Rubber Co., Electrical Wire & Cable Dept.

COUPLERS, AUTOMATIC MINE-CAR

American Steel Foundries—"AMERICAN"
Card, C. S., Iron Works Co.
Enterprise Wheel & Car Dept.
Mayo Tunnel & Mine Equipment Co.—"MAYO AUTOMATIC"
National Malleable & Steel Castings Co.—"WILLISON"
Ohio Brass Co.
Rydin Railway Equipment Co.

COUPLERS, CABLE

General Electric Co., Construction Materials Dept.

COUPLERS, MINE-CAR, PINS-AND-LINK

Duquesne Mine Supply Co.

COUPLINGS, AIR

Cleco Div., Reed Roller Bit Co.—"CLECO-DALLETT"
Howells Mining Drill Co.
Lincoln Engineering Co.
Snap-Tite, Inc.—"QUICK-CONNECT"

COUPLINGS, DEMOUNTABLE, MINE HOSE

American Brattice Cloth Corp.

COUPLINGS, FIRE HOSE

Fyr-Fyter Co.

COUPLINGS, FLEXIBLE SHAFT

Ajax Flexible Coupling Co.
Browning Mfg. Co.
Chain Belt Co.—"REX"
Continental Gin Co., Industrial Div.
De Laval Steam Turbine Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.—"TAPER-LOCK"
Elliott Co.
Falk Corp.
Herold Mfg. Co.
James Gear Mfg. Co., D. O.
Jeffrey Mfg. Co.
Jones Foundry & Machine Co., W. A.
Koppers Co., Inc., Metal Products Div.—"FAST'S"
Link-Belt Co.—"LINK-BELT"
Lovejoy Flexible Coupling Co.
McNally Pittsburg Mfg. Corp.
Morse Chain Co., A Borg-Warner Industry—"MORFLEX"
Thomas Flexible Coupling Co.—"THOMAS"
Transall, Inc.
Whitney Chain Co.
Woods Sons Co., T. B.—"SURE GRIP"
Zurn Mfg. Co., American Flexible Coupling Div.—"AMERIGEAR," "AMERICAN"

COUPLINGS, FLUID

American Blower Corp.—"GYROL FLUID DRIVE"
Dodge Mfg. Corp.—"FLEXIDYNE"
Link-Belt Co.—"LINK-BELT"
Transall, Inc.
Twin Disc Clutch Co.—"HYDRO-SHEAVE"

COUPLINGS, FLUID, SELF-SEALING

Aeroquip Corp.

COUPLINGS, HOSE

Hose Accessories Co., Le-Hi Div.—"LE-HI"
Lincoln Engineering Co.
Manhattan Rubber Div., Raybestos Manhattan, Inc.

COUPLINGS, HYDRAULIC
Snap-Tite, Inc.—"QUICK-CONNECT"

COUPLINGS, MAGNETIC, EDDY CURRENT
Dynamatic Div., Eaton Mfg. Co.

CRANES, CRAWLER
American Hoist & Derrick Co.

CRANES, RUBBER-TIRED
LeTourneau-Westinghouse Co.—"TOURNAPULL"

CRANES, SHOP AND PLANT
Austin Western Co., Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Harnischfeger Corp.—"P&H"
Mahon Co., R. C.
Orton Crane & Shovel Co.
Robbins & Meyers, Inc.—"R&M"
Ruger Equipment, Inc.—"RUGER"
Shaw Box Crane & Hoist Div., Manning, Maxwell & Moore, Inc.—"SHAW-BOX," "LOAD-LIFTER"
Shepard Niles Crane & Hoist Corp.
Whiting Corp.
Wright Hoist Div., American Chain & Cable Co., Inc.

CRANES, TRACTOR AND TRUCK
Austin-Western Co., Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bucyrus-Erie Co.
Clark Equipment Co., Construction Machinery Div.
Clinetruck Co.
Gar Wood Industries, Inc.
Harnischfeger Corp.—"P&H"
Hendrickson Mfg. Co.
Hyster Co.—"HYSTER," "KARRY KRANE," "HYSTAWAY"
Koehring Co.
Link-Belt Speeder Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Orton Crane & Shovel Co.
Pettibone-Mulliken Corp.
Pitman Mfg. Co.—"HYDRA-LIFT," "PITMAN"
Ruger Equipment, Inc.—"RUGER"
Schield Bantam Co.—"BANTAM"
Thew Shovel Co.
Unit Crane & Shovel Corp.

CRANES, TRUCK
American Hoist & Derrick Co.
Bay City Shovels, Inc.

CROSSING SIGNALS, RAIL, HIGHWAY
Nachod & U. S. Signal Co.

CRUSHERS, HAMMER
American Pulverizer Co.
Allis-Chalmers Mfg. Co.
Bartlett, C. O., & Snow Co.
Buffalo Hammer Mill Corp.
Crusher Engineering Div., Poor & Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Holmes & Bros., Inc., Robert
Insley Mfg. Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Morse Bros. Machinery Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Pettibone-Mulliken Corp.
Sprout, Waldron & Co., Inc.
Sturtevant Mill Co.
Universal Engineering Co.
Webb Corp.
Williams Patent Crusher & Pulverizer Co.

CRUSHERS, LABORATORY
Wise Co., O. B.

CRUSHERS, REPLACEMENT PARTS
Electric Steel Foundry

CRUSHERS, RING
American Pulverizer Co.
Crusher Engineering Div., Poor & Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Stephens-Adamson Mfg. Co.
Williams Patent Crusher & Pulverizer Co.

CRUSHERS, ROLL
Allis-Chalmers Mfg. Co.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.—"BONDED"
Crusher Engineering Div., Poor & Co.
Denver Equipment Co.
Eagle Iron Works
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins, Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co.—"LINK-BELT"
McLanahan & Stone Corp.—"BANTAMS," "BLACK DIAMONDS," "ROCK MASTERS," "PIONEER," "STEELSTRUT"
McNally Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Pettibone, Mulliken Corp.
Pioneer Engineering Works, Inc.
Ridge Equipment Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Traylor Engineering & Mfg. Co.
Universal Engineering Co.
Webb Corp.
Williams Patent Crusher & Pulverizer Co.
Wilmot Engineering Co.

CRUSHERS, SAMPLE
American Pulverizer Co.

CRUSHERS, SAWTOOTH
Sprout, Waldron & Co., Inc.

CRUSHERS, SCREW
Joy Mfg. Co.

CRUSHERS, TWO-STAGE
Bartlett, C. O., & Snow Co.
Crusher Engineering Div., Poor & Co.
Electric Steel Foundry
Gruendler Crusher & Pulverizer Co.
Gundlach Machine Co., T. J., Div. of J. M. J. Industries, Inc.—"GUNDLACH"
Iowa Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co.—"LINK-BELT"
Pettibone Mulliken Corp.
Pioneer Engineering Works, Inc.
Universal Engineering Co.
Webb Corp.
Williams Patent Crusher & Pulverizer Co.

CUT-OUTS, ELECTRICAL
Duquesne Mine Supply Co.
General Electrical Co., Apparatus Sales Div.
Graybar Electric Co., Inc.

CUTTER BARS
Bowdil Co.
Cincinnati Mine Machinery Co.—"CINCINNATI"
Prox Co., Inc., Frank
Tracy Co., Bertrand P.

CUTTER BITS
Allegheny Ludlum Steel Corp., Carmet Div.
Bowdil Co.
Carboloy Dept. of General Electric Co.
Cardox Corp.
Central Mine Equipment Co.
Cincinnati Mine Machinery Co.—"CINCINNATI"
Goodman Mfg. Co.
Joy Mfg. Co.
Kennametal, Inc., Mining Div.
Leetonia Tool Co.
Metal Carbides Corp.
Salem Tool Co.—"SALEM," "BLACK DIAMOND," "HERCULES"
Savage Co., W. J.
Schroeder Brothers
Tracy Co., Bertrand P.
Vascoloy-Ramet Corp.

CUTTER BITS, ALLOY & TIPPED
Bowdil Co.
Cardox Corp.
Cutter Bit Service Co.—"CUT-RITE"
Central Mine Equipment Co.
Joy Mfg. Co.
Metal Carbides Corp.
National Mine Service Co.
Salem Tool Co.—"SALEM," "BLACK DIAMOND," "HERCULES"
Savage Co., W. J.
Vascoloy-Ramet Corp.

CUTTER BITS, CARBIDE-TIPPED
Allegheny Ludlum Steel Corp., Carmet Div.
Bowdil Co.
Carboloy Dept. of General Electric Co.
Cincinnati Mine Machinery Co.—"CINIDE"
Cutter Bit Service Co.—"CUT-RITE"
Firth Sterling, Inc.—"FIRTHITE"
Joy Mfg. Co.
Kennametal, Inc., Mining Div.
Metal Carbides Corp.
National Mine Service Co.
Newcomer Products—"NEWCOMER"
Penn Machine Co.
Salem Tool Co.—"SALEM," "BLACK DIAMOND," "HERCULES"
Savage Co., W. J.
Vascoloy-Ramet Corp.

CUTTER BITS, THROWAWAY
Bowdil Co.
Cardox Corp.
Central Mine Equipment Co.
Cincinnati Mine Machinery Co.—"DUPLEX," "STANEX"
Goodman Mfg. Co.
Joy Mfg. Co.
Kennametal, Inc., Mining Div.
Marathon Coal Bit Co.—"MARATHON DOUBLE END"
Penn Machine Co.
Prox Co., Inc., Frank
Salem Tool Co.—"SALEM," "BLACK DIAMOND," "HERCULES"

CUTTER CHAINS
Bowdil Co.
Cincinnati Mine Machinery Co.—"CINCINNATI"
Prox Co., Inc., Frank
Tracy Co., Bertrand P.

CUTTERS, BAR & WIRE ROPE
Beaver Pipe Tools, Inc.
Bowdil Co.
Porter, Inc., H. K.—"NEW EASY HKP"

CUTTERS, BOLT, CABLE, ROD & CHAIN
Porter, Inc., H. K.—"NEW EASY HKP"

CUTTING MACHINES
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.

CUTTING MACHINES, CONVERTED, TRACK TO RUBBER
Lee-Norse Co.

CYCLONES
Centrifugal & Mech. Industries, Inc.—"C-M-I CLUST-R-CLONE"
Door-Oliver, Incorporated—"DORRCLONE"
Fairmont Machinery Co.
Heyl & Patterson, Inc.
McNally Pittsburg Mfg. Corp.
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

CYCLONES, AIR
Bartlett, C. O., & Snow Co.
Combustion Engineering, Inc., Raymond Div.
Ducon Co.
U. S. Hoffman Machinery Corp.

DERAILERS
American Mine Door Co.—"ELECTRI-THROW"
Gibraltar Equipment & Mfg. Co.
Miner's Hardware Supply
Nolan Co.
West Virginia Steel & Mfg. Co.

DERAILERS, ELECTRIC, AUTOMATIC AND REMOTE CONTROLLED
Cheatham Electric Switching Device Co.

DERRICKS, STEEL, GUY & STIFFLEG
American Hoist & Derrick Co.

DESIGN, TIPPLES & WASHERS
Western Knapp Engineering—"WKE"

DETECTORS, TRAMP-IRON
Dings Magnetic Separator Co.
General Electric Co., Apparatus Sales Div.
Radio Corp. of America, Inspection & Control

DETERGENT, GERMICIDAL
American Optical Co.

DETONATOR BOXES, WOOD
Hammond Co., J. V.

DETONATORS, ELECTRIC
American Cyanamid Co., Explosives Dept.
Atlas Powder Co.—"MANASITE"
Austin Powder Co.
duPont de Nemours & Co., Inc., E. I.
Hercules Powder Co.
Liberty Powder Co., Subsidiary of Olin Mathieson Chemical Corp.
National Powder Co.
Olin Mathieson Chemical Corp., Explosives Div.—"OLIN"

DETONATORS, MILLISECOND DELAY
American Cyanamid Co., Explosives Dept.
Atlas Powder Co.—"ROCKMASTER"
Austin Powder Co.
duPont de Nemours & Co., Inc., E. I.
Femco, Inc.
Hercules Powder Co.
Liberty Powder Co., Subsidiary of Olin Mathieson Chemical Corp.
National Powder Co.
Olin Mathieson Chemical Corp., Explosives Div.—"OLIN"

DETONATORS, SHORT DELAY
Hercules Powder Co.

DETONATORS, STANDARD DELAY
American Cyanamid Co., Explosives Dept.
Atlas Powder Co.
Austin Powder Co.
duPont de Nemours & Co., Inc., E. I.
Hercules Powder Co.
Liberty Powder Co., Subsidiary of Olin Mathieson Chemical Corp.
National Powder Co.
Olin Mathieson Chemical Corp., Explosives Div.—"OLIN"

DIAMONDS, INDUSTRIAL
Hoffman Bros. Drilling Co.

DIPPER & BUCKET TEETH, BASES
H. & L. Tooth Co.

DIPPER & BUCKET TEETH, BASES, INSERTS, ETC.
American Brake Shoe Co.—"AMSCO WEARSHARP REPOINTERS," "CAST-TO-SHAPE REPOINTERS"
American Steel Foundries—"WEARPACT"
Electric Steel Foundry
Haiss Div., George, Pettibone Mulliken Corp.
Mahon Co., R. C.
Taylor-Wharton Iron & Steel Co.

DIPPERS, SHOVEL
American Brake Shoe Co.
American Manganese Steel Div., American Brake Shoe Co.
Electric Steel Foundry
Haiss Div., George, Pettibone Mulliken Corp.
Koehring Co.
Mahon Co., R. C.
Marion Power Shovel Co.
Pettibone Mulliken Corp.
Taylor-Wharton Iron & Steel Co.

DISCS, RENEWABLE COMPOSITION
Jenkins Bros.

DISTRIBUTION BOXES, ELECTRICAL
Anderson Mfg. Co., Albert & J. M.
Elreco Corp.
Graybar Electric Co., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Ohio Brass Co.

DISTRIBUTION BOXES, ELECTRICAL, MINE
Anderson Mfg. Co., Albert & J. M.
Ensign Electric & Mfg. Co.

DISTRIBUTORS, HYDRAULIC
Heyl & Patterson, Inc.

DOORS, AIR-POWERED
American Mine Door Co.

DOORS, MINE, AUTOMATIC
American Mine Door Co.

DRAFT GEAR, RUBBER
National Malleable & Steel Casting Co.—"NATIONAL MUTI-PAD"

DRAFTING EQUIPMENT, SUPPLIES
Berger, C. L. & Sons, Inc.—"BERGER"
Bruning Co., Inc., Charles
Dietzgen Co., Inc., Eugene
Dixon Crucible Co., Joseph
Geo-Optic Co., Inc.
Keuffel & Esser Co.
Wild Heerbrugg Instruments, Inc.

DRAGLINES, CRAWLER
Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Gar Wood Industries, Inc.
Harnischfeger Corp.—"P&H"
Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Orton Crane & Shovel Co.
Schield Bantam Co.—"BANTAM"
Thew Shovel Co.
Unit Crane & Shovel Corp.

DRAGLINES, RUBBER-TIRED
Thew Shovel Co.

DRAGLINES, WALKING
Bucyrus-Erie Co.
Marion Power Shovel Co.
Page Engineering Co.

DRIERS, CENTRIFUGAL
Centrifugal & Mechanical Industries, Inc., "C-M-I"
Heyl & Patterson, Inc.—"REINEVELD"
Kanawha Mfg. Co.
McNally Pittsburg Mfg. Corp.

DRIERS, CENTRIFUGAL, SCREEN-TYPE, SOLID-BOWL
Bird Machine Co.

DRIERS, HEAT
Allis-Chalmers Mfg. Co.
Bartlett, C. O., & Snow Co.
Bigelow-Liptak Corp.
Combustion Engineering, Inc., Raymond Div.—"FLASH DRYERS"
Davis Co., Nelson L.
Denver Equipment Co.
Dorr-Oliver Incorporated—"FLUOSOLIDS"
Dravo Corp.
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert—"BAUGHMAN VERTI-VANE"
Link-Belt Co.—"MULTI-LOUVRE"
Louisville Dryer Div., General American Transportation Corp.
McNally Pittsburg Mfg. Corp.
Reintjes Co., George P.
Silver Engineering Works, Inc.—"PARRY"
Wyssmont Co.—"TURBO-DRYER"
Universal Engineering Co.

DRILL AUGERS
Bowdil Co.
Cardox Corp.
Central Mine Equipment Co.
Compton, Inc.
Dooley Bros.
Gardner-Denver Co.—"GARDNER-DENVER"
Howells Mining Drill Co.
Joy Mfg. Co.
Kennametal, Inc., Mining Div.
Leetonia Tool Co.
Mall Tool Co.
Mayhew Supply Co.
McLaughlin Mfg. Co.
Mobile Drilling, Inc.
National Mine Service Co.
Salem Tool Co.—"SALEM," "HERCULES"
Thor Power Tool Co.
Vascoloy-Ramet Corp.

DRILL BITS, COAL
Allegheny Ludlum Steel Corp., Carmet Div.—"CARMET"
Bowdil Co.
Carboloy Dept., General Electric Co.
Cardox Corp.
Central Mine Equipment Co.
Compton, Inc.
Firth Sterling, Inc.—"FIRTHITE"
Gibraltar Equipment & Mfg. Co.
Howells Mining Drill Co.
Kennametal, Inc., Mining Div.
Leetonia Tool Co.
McLaughlin Mfg. Co.
Mobile Drilling Co., Inc.
National Mine Service Co.
Newcomer Products—"NEWCOMER"
Prox Co., Inc., Frank
Salem Tool Co.—"SALEM," "HERCULES"
Schroeder Brothers
Thor Power Tool Co.
Vascoloy-Ramet Corp.

DRILL BITS, CORE

Acker Drill Co.
Carboloy Dept., General Electric Co.
Failing Co., George E.
Joy Mfg. Co.
Kennametal, Inc., Mining Div.
Longyear Co., E. J.
Mayhew Supply Co, Inc.
Mobile Drilling Co., Inc.
Mott Core Drilling Co.
Newcomer Products—"NEWCOMER"
Pennsylvania Drilling Co.
Salem Tool Co.
Vascoloy-Ramet Corp.

DRILL BITS, DIAMOND

Hoffman Brothers Drilling Co.
Sprague & Henwood

DRILL BITS, MOLEFOOT, STRIPPING

Cardox Corp.
Central Mine Equipment Co.
Mobile Drilling Co., Inc.—"SALEM"
Salem Tool Co.—"SALEM"

DRILL BITS, PERCUSSION

Acme Machinery Co.
Brunner & Lay, Inc.
Bucyrus-Erie Co.
Carboloy Dept., General Electric Co.
Cleveland Rock Drill Div., Westinghouse Air Brake Co.
Davey Compressor Co.
Gardner-Denver Co.—"GARDNER-DENVER"
Ingersoll-Rand Co.
Joy Mfg. Co.
Kennametal, Inc., Mining Div.
Mobile Drilling Co., Inc.
Spang & Co.
Stardrill-Keystone Co.
Throwaway Bit Corp.
Timken Roller Bearing Co.
Vascoloy-Ramet Corp.

DRILL BITS, PERCUSSION, CARBIDE-TIPPED

Brunner & Lay, Inc.

DRILL BITS, ROOF

Acme Machinery Co.
Allegheny Ludlum Steel Corp., Carmet Div.—"CARMET"
Carboloy Dept., General Electric Co.
Cleveland Rock Drill Div., Westinghouse Air Brake Co.
Joy Mfg. Co.
Kennametal, Inc., Mining Div.
Mobile Drilling Co., Inc.
National Mine Service Co.
Newcomer Products—"NEWCOMER"
Timken Roller Bearing Co.
Vascoloy-Ramet Corp.

DRILL BITS, ROOF, CARBIDE-TIPPED

Firth Sterling, Inc.—"FIRTHITE"

DRILL BITS, ROTARY, DRY, STRIPPING

Carboloy Dept., General Electric Co.
Cardox Corp.
Central Mine Equipment Co.
Davey Compressor Co.
Failing Co., George E.
Hawthorne, Inc., Herb J.—"BLUE DEMON"
Hoffman Bros. Drilling Co.
Hughes Tool Co.
Mayhew Supply Co.
Mobile Drilling Co., Inc.
Varel Mfg. Co.
Vascoloy-Ramet Corp.
Winter-Weiss Co.

DRILL BITS, ROTARY, WET, STRIPPING

Carboloy Dept., General Electric Co.
Cardox Corp.
Davey Compressor Co.
Failing Co., George E.
Hawthorne, Inc., Herb J.—"BLUE DEMON"
Hoffman Bros. Drilling Co.
Hughes Tool Co.
Mayhew Supply Co.
Mobile Drilling, Inc.
Varel Mfg. Co.
Vascoloy-Ramet Corp.
Winter-Weiss Co.

DRILL BITS, ROTARY, WET, STRIPPING, CARBIDE-TIPPED

Firth Sterling, Inc.—"FIRTHITE"

DRILL JUMBOS

Acme Machinery Co.
Chicago Pneumatic Tool Co.
Cleveland Rock Drill Div., Westinghouse Air Brake Co.
Gardner-Denver Co.—"GARDNER-DENVER"
Ingersoll-Rand Co.
Joy Mfg. Co.
Mayo Tunnel & Mine Equipment Co.
Thor Power Tool Co.
Winter-Weiss Co.

DRILL PIPE

Davey Compressor Co.
Varel Mfg. Co., Inc.

DRILL PRESSES, BENCH & FLOOR

South Bend Lathe Works

DRILL SHARPENERS

Gardner-Denver Co.—"GARDNER-DENVER"
Ingersoll-Rand Co.

DRILL STEEL

Acme Machinery Co.
Bethlehem Steel Co.
Brunner & Lay, Inc.
Cleveland Rock Drill Div., Westinghouse Air Brake Co.
Crucible Steel Co. of America
Davey Compressor Co.
Gardner-Denver Co.—"GARDNER-DENVER"
Gibraltar Equipment & Mfg. Co.
Goodman Mfg. Co.
Howells Mining Drill Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Mayhew Supply Co.
National Mine Service Co.
Ryerson & Son, Inc., Joseph
Throwaway Bit Co.
Vascoloy-Ramet Corp.

DRILLS, COAL, FLEXIBLE-SHAFT

Jeffrey Mfg. Co.
Leetonia Tool Co.

DRILLS, COAL, HAND

Salem Tool Co.—"SALEM"

DRILLS, COAL, HAND-HELD

Chicago Pneumatic Tool Co.
Cincinnati Electrical Tool Co.
Cleveland Rock Drill Div., Westinghouse Air Brake Co.
Dooley Bros.
Howells Mining Drill Co.
Ingersoll-Rand Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Thor Power Tool Co.

DRILLS, COAL, HAND-HELD HYDRAULIC

Schroeder Brothers

DRILLS, COAL, MOUNTED SELF-PROPELLED

Chicago Pneumatic Tool Co.
Dooley Bros.
Failing Co., George E.
Herold Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Lee-Norse Co.—"LEE NORSE DRILL TRUCK"
Penn Machine Co.
Salem Tool Co.—"McCARTHY"
Schramm, Inc.

DRILLS, COAL, POST-MOUNTED

Chicago Pneumatic Tool Co.
Dooley Bros.
Goodman Mfg. Co.
Howells Mining Drill Co.
Herold Mfg. Co.
Ingersoll-Rand Co.
Jeffrey Mfg. Co.
Leetonia Tool Co.
Penn Machine Co.
Salem Tool Co.—"SALEM"

DRILLS, CORE

Acker Drill Co.
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Failing Co., George E.
Hoffman Bros. Drilling Co.
Joy Mfg. Co.
Longyear Co., E. J.
Mayhew Supply Co.
Mobile Drilling Co., Inc.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Reich Bros. Mfg. Co.
Sprague & Henwood, Inc.
Winter-Weiss Co.

DRILLS, OVERBURDEN, SIDEWALL

Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Mobile Drilling Co., Inc.
Paris Mfg. Co.
Salem Tool Co.—"McCARTHY"

DRILLS, OVERBURDEN, TRACTOR-MOUNTED PNEUMATIC

Cleveland Rock Drill Div., Westinghouse Air Brake Co.
Gardner-Denver Co.
Ingersoll-Rand Co.
Joy Mfg. Co.—"CHALLENGER"
Schramm, Inc.
Stardrill-Keystone Co.

DRILLS, OVERBURDEN, VERTICAL CHURN

Bucyrus-Erie Co.
Hossfeld Mfg. Co., Prospecting Drill Div.
Schramm, Inc.

DRILLS, OVERBURDEN, VERTICAL ROTARY

Bucyrus-Erie Co.
Cardox Corp.
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Failing Co., George E.
Joy Mfg. Co.—"CHAMPION," "BLAST-AIR"
Mayhew Supply Co.
Paris Mfg. Co.
Reich Bros. Mfg. Co.
Salem Tool Co.—"McCARTHY"
Schramm, Inc.
Winter-Weiss Co.—"PORTADRILL"

DRILLS, PNEUMATIC, ROCK

Cleveland Rock Drill Div., Westinghouse Air Brake Co.

DRILLS, ROOF-BOLTING

Chicago Pneumatic Tool Co.
Dooley Bros.
Fletcher & Co., J. H.
Goodman Mfg. Co.

DRILLS, STRIP-COAL, TRACTOR MOUNTED, PNEUMATIC

Cardox Corp.
Ingersoll-Rand Co.
Joy Mfg. Co.
Schramm, Inc.

DRILLS, STRIP-COAL, VERTICAL ELECTRIC

Cardox Corp.
Joy Mfg. Co.
Paris Mfg. Co.
Salem Tool Co.—"McCARTHY"

DRIVES

American Blower Corp.—"GYROL FLUID DRIVE"

DRIVES, ADJUSTABLE SPEED

Electrical Machinery Mfg. Co.

DRIVES, EMERGENCY—FANS, BLOWERS & PUMPS

Marland One-Way Clutch Co.

DRIVES, GEAR

Falk Corp.

DRIVES, V-BELT

Jones Foundry & Machine Co., W. A.

DUCKBILL LOADING HEADS

Goodman Mfg. Co.

DUCTS, AIR

Flexible Tubing Corp.

DUMPS, CROSSOVER, KICKBACK

Bartlett, C. O., & Snow Co.
Card, C. S., Iron Works Co.
Link-Belt Co.—"LINK-BELT"
Nolan Co.

DUMPS, ROTARY

Atlas Car & Mfg. Co.
Card, C. S., Iron Works Co.
Connellsville Mfg. & Mine Supply Co.
Differential Steel Car Co.
Fairmont Machinery Co.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
McNally Pittsburg Mfg. Corp.
Nolan Co.
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Rogers Iron Wks. Co.
Wellman Engineering Co.

DUST COLLECTORS, COAL HANDLING, PREPARATION

American Air Filter Co., Inc.—"ROTO-CLONE," "AMER-CLONE"
American Wheelabrator & Equipment Corp. —"DUSTUBE"
Buell Engineering Co., Inc.
Ducon Co.
Fairmont Machinery Co.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Johnson-March Corp.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Kinney Engineers, Inc., S. P.
McNally Pittsburg Mfg. Corp.
Mechanical Industries, Inc.
Pangborn Corp.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

DUST COLLECTORS, MINE & DRILL

Acme Machinery Co.
American Air Filter Co., Inc.—"ROTO-CLONE"
Browning Dust Collector Co.
Davey Compressor Co.
Ducon Co.
Fletcher & Co., J. H.
Goodall Mfg. Co.
Goodman Mfg. Co.
Holmes & Bros., Inc., Robert
Mayhew Supply Co.
Mine Safety Appliances Co.—"DRILDUST" BUCKET
Penn Machine Co.

DUST COLLECTORS, MECHANICAL

American Blower Corp.

DUST FILTERS, PLANT

American Air Filter Co., Inc.
Ducon Co.
Kanawha Mfg. Co.
Kinney Engineers, Inc., S. P.
Mine Safety Appliances Co.
Pangborn Corp.

DUST COLLECTORS, VACUUM

U. S. Hoffman Machinery Corp.

DUST CONTROL

Viking Machinery Sales Co.—"VIKING HOT-OIL"

DUST CONTROL SYSTEMS, LIQUID

Johnson-March Corp.

DUST SAMPLERS

Fisher Scientific Co.
Mayhew Supply Co.
Mine Safety Appliances Co.
Willson Products, Inc.

EDUCATION, FOREMEN, SUPERVISORS

Elliott Service Co., Inc., Coal Mine Poster Div.—"MANAGEMENT INFORMATION WEEKLY"

ELEVATORS, BELT

Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.
Boston Woven Hose & Rubber Co.
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Continental Gin Co., Industrial Div.
Davis Co., Nelson L.
Fairfield Engineering Co.
Fairmont Machinery Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co., Inc.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Kremser & Sons, Inc., Frank A.
Lippmann Engineering Works
Link-Belt Co.—"LINK-BELT"
McNally Pittsburg Mfg. Corp.
New York Belting & Packing Co.—"INDUSTRUCTIBLE PALISADE"
Quaker Rubber Corp., Div. of H. K. Porter, Inc., of Pittsburgh
Republic Rubber Div., Lee Tire & Rubber Corp.
Savage Co., W. J.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall, Inc.
Webster Mfg., Inc.
United States Rubber Co., Mechanical Goods Div.
Universal Engineering Co.

ELEVATORS, BUCKET

Barber-Greene Co.
Bartlett, C. O., & Snow Co.
Baughman Mfg. Co.
B-I-F Industries, Inc., Omega Machine Co. Div.
Bonded Scale & Machine Co.
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Construction Machinery Co.
Continental Gin Co., Industrial Div.
Davis Co., Nelson L.
Fairfield Engineering Co.
Fairmont Machinery Co.
Gibraltar Equipment & Mfg. Co.
Goodyear Tire & Rubber Co., Inc.
Haiss Div., George, Pettibone Mulliken Corp.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Kremser & Sons, Inc., Frank A.
Lippmann Engineering Works
Link-Belt Co.—"LINK-BELT"
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Pioneer Engineering Works, Inc.
Ridge Equipment Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Salem Tool Co.—"SALEM"
Savage Co., W. J.
Sprout, Waldron & Co., Inc.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall, Inc.
Webster Mfg. Co.
Wilmot Engineering Co.
Universal Engineering Co.

ELEVATORS, MEN & SUPPLIES

Holmes & Bros., Inc., Robert
Mayo Tunnel & Mine Equipment Co.

ELEVATORS, SHUTTLE-CAR TRANSFER

Joy Mfg. Co.

ENGINE-GENERATOR SETS

Allis-Chalmers Mfg. Co.
Allis-Chalmers Mfg. Co., Buda Div.
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Cummins Engine Co.
Detroit Diesel Engine Div., General Motors Corp.
Diesel Energy Corp.
Fairbanks-Morse & Co.
Graybar Electric Co., Inc.
Harnischfeger Corp.—"P&H"
Hobart Bros.—"HOBART"
Homelite Corp.—"HOMELITE"
Kloeckner-Humboldt-Deutz AG, c/o Diesel Energy Corp.
Le Roi Div., Westinghouse Air Brake Co.
Lincoln Electric Co.—"WELDANPOWER"
Murphy Diesel Co.
Nordberg Mfg. Co.
Ready Power Co.—"READY-POWER"
Worthington Corp.

ENGINE OILS, DIESEL

D-A Lubricant Co., Inc.—"D-A DIESEL OIL"

ENGINEERS, BLASTING-VIBRATION

Vibration Measurement Engineers
White, Harold H.

ENGINEERS, CONSULTING

Alford, Newell Co.
Baton & Co., Geo. S.
Castanoli, Alder F.
Christian Engineers, J. D.
Dorr-Oliver Incorporated
Evanson, Auchmuty & Summers
Fairchild Aerial Survey, Inc.
Fetterman Engineering Co.
Fletcher, J. H.
Fuel Process Co.
Herold Mfg. Co.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robert
Kirk & Cowin
Link-Belt Co.
Littlewood, Herbert S.
Loftus Corp., Peter F.
Mahon Co., R. C.
Manu-Mine Research & Development Co.
Marsh Engineering Co., E. F.
Mayo, Robert S.
McNally Pittsburg Mfg. Corp.
Meckum Engineering Co.
Meissner, John F., Engineers, Inc.
Mott Core Drilling Co.
Pierce Management Corp.
Peters, Chester M. F.
Prins & Associates, K.
Read, Davis

Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Savage Co., W. J.
Silver Engineering Works, Inc.
Weir Co., Paul
WEMCO Div., Western Machinery Co.
Western Knapp Engineering Co.
Woomer & Associates, J. W.
World Mining Consultants, Inc.

ENGINEERS, CONSULTING ELECTRICAL

West Virginia Electric Corp.

ENGINEERS, CONSULTING AND CONSTRUCTING

Allen & Carcia Co.

ENGINEERS, CONSULTING & DESIGNING

Templeton-Matthews Corp.

ENGINEERS, CONSULTING, GEOLOGISTS

Longyear Co., E. J.

ENGINEERS, CONSULTING, MINING & INDUSTRIAL

Robinson & Robinson

ENGINES, DIESEL

Allis-Chalmers Mfg. Co.
Allis-Chalmers Mfg. Co., Buda Div.
Baldwin-Lima-Hamilton Corp.
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Compton, Inc.
Continental Motors Corp.
Cummins Engine Co.
Detroit Diesel Engine Div., General Motors Corp.
Diesel Energy Corp.
Fairbanks-Morse & Co.
Ford Motor Co., Industrial Engine Dept.
Harnischfeger Corp.—"P&H"
Hercules Motors Corp.
International Harvester Co.
Klockner-Humboldt-Deutz AG, c/o Diesel Energy Corp.
Minneapolis-Moline Co.—"MM INDUSTRIAL"
Murphy Diesel Co.
Nordberg Mfg. Co.
Oliver Corp.—"OLIVER POWER UNITS"
Page Engineering Co.
Waukesha Motor Co.
Worthington Corp.

ENGINES, DIESEL AUTOMOTIVE

Mack Motor Truck Corp.

ENGINES, DUAL-FUEL

Murphy Diesel Co.

ENGINES, GASOLINE

Allis-Chalmers Mfg. Co.
Allis-Chalmers Mfg. Co., Buda Div.
Continental Motors Corp.
Fairbanks-Morse & Co.
Ford Motor Co., Industrial Engine Dept.
Harnischfeger Corp., P&H Diesel Engine Div.—"P&H"
Hercules Motors Corp.
International Harvester Co.
Le Roi Div., Westinghouse Air Brake Co.
Mall Tool Co.
Minneapolis-Moline Co.—"MM INDUSTRIAL"
Oliver Corp.—"OLIVER POWER UNITS"
Reo Motors—"GOLD COMET"
Waukesha Motor Co.
Wisconsin Motor Corp.

ENGINES, GASOLINE, AUTOMOTIVE

Mack Motor Truck Corp.

ENGINES, OIL

Wisconsin Motor Corp.

EXHAUSTERS, CENTRIFUGAL, MULTISTAGE

U. S. Hoffman Machinery Corp.

EXPANSION PLUGS, ROOF-BOLTING

Elreco Corp.
National Mine Service Co.
Ohio Brass Co.

EXPLOSIVES, COAL

American Cyanamid Co., Explosives Dept.
Atlas Powder Co.—"COALITE PERMISSIBLES"
duPont de Nemours & Co., E. I.—"DUOBEL," "MONOBEL," "LUMP COAL," "GELOBEL"
Hercules Powder Co.
Illinois Powder Mfg. Co.—"BLACK DIAMOND PERMISSIBLES"
King Powder Co.
Liberty Powder Co., Sub. Olin Mathieson Chemical Corp.
National Powder Co.
Olin-Mathieson Chemical Corp.

EXPLOSIVES, ROCK

American Cyanamid Co., Explosives Dept.
Atlas Powder Co.—"APEX"
Austin Powder Co.
duPont de Nemours & Co., E. I.—"RED CROSS EXTRA," "DuPONT EXTRA," "SPECIAL GELATIN," "GELEX"
Hercules Powder Co.
Hoffman Bros. Drilling Co.
Illinois Powder Mfg. Co.—"GOLD MEDAL DYNAMITE"
King Powder Co., Inc.
Liberty Powder Co., Sub. Olin Mathieson Chemical Corp.
National Powder Co.
Olin Mathieson Chemical Corp.

EXPLOSIVES, ROCK, LIQUID-OXYGEN TYPE

Airmite-Midwest, Inc.—"AIRMITE"

EXPLOSIVES PACKAGING, PLASTIC

Visking Corp., Plastics Div.—"VISQUEEN"

EYEBOLTS, NUTS

Upson Walton Co.

EYE SHIELDS

Bausch & Lomb Optical Co.
Bullard Co., E. D.
Fisher Scientific Co.
General Scientific Equipment Co.
Martindale Electric Co.
Mine Safety Appliances Co.—"FACEGARD"
Pulmosan Safety Equipment Co.
Willson Products, Inc.—"PROTECTO-SHIELD"

FABRICATORS

Falk Corp.
Silver Engineering Works, Inc.

FABRICATORS, STEEL AND STRUCTURES

Arrowhead Steel Buildings, Inc.
Black, Sivalls, Bryson, Inc.
Christian Engineers, J. D.
Connellsville Mfg. & Mine Supply Co.
Fairmont Machinery Co.
Foster Wheeler Corp.
Helmick Foundry-Machine Co.
Heyl & Patterson, Inc.
Holmes & Bros., Robert
Industrial Engr. & Construction Co.
Industrial Machine & Electric Co.
Kanawha Mfg. Co.
Mahon Co., R. C.
McNally Pittsburg Mfg. Corp.
Meckum Engineering Co.
Philips Div., Salem-Brosius, Inc.
Prins & Associates, K.
Red Jacket Co., Inc.
Savage Co., W. J.
Steel Built Construction Co.
Thomas Engineering & Construction Co.
Vincennes Steel Corp.
Vulcan Iron Works

FACE SHIELDS

American Optical Co.

FAN SIGNALS

Femco, Inc.
Nachod & U. S. Signal Co.

FANS, VENTILATING

American Air Filter Co., Inc.—"HERMAN NELSON"
American Blower Corp.—"VENTURA"
Carey Mfg. Co.—"MIAMI-CAREY"
Chelsea Fan & Blower Co., Inc.—"CHELSEA, POWER-LINE"
Clarage Fan Co.
Graybar Electric Co., Inc.
Guyan Machinery Co.—GUYAN "VENTA-MINE"
Hannon & Sons, F. R.—"HANCO"
Hartzell Propeller Fan Co. Div., Castle Hill Corp.
Ilg Electric Ventilating Co.
Industrial Machine & Electric Co.
Joy Mfg. Co.—"AXIVANE"
Jeffrey Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
McNally Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Robbins & Meyers—"PROPELLAIR"
Robinson Ventilating Co.
Sturtevant Div., B. F., Westinghouse Electric Corp.
Westinghouse Electric Corp.
Wing Mfg. Co., L. J.—"WINGFOIL"

FEED DISTRIBUTORS, REVOLVING

Deister Concentrator Co.—"CONCENCO"

FEEDERS, APRON

Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Connellsville Mfg. & Supply Co.
Continental Gin Co., Industrial Div.
Denver Equipment Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Industrial Machine & Electric Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.—"LINK-BELT"
Lippmann Engineering Works
McLanahan & Stone Corp.
Morse Bros. Machinery Co.
Pettibone Mulliken Corp.
Pioneer Engineering Works, Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Straub Mfg. Co.
Taylor-Wharton Iron & Steel Co.
Transall, Inc.
Traylor Engineering & Mfg. Co.
Universal Engineering Co.
Webster Mfg., Inc.

FEEDERS, BELT

Galigher Co.—"GALIGHER"
WEMCO Div., Western Machinery Co.—"WEMCO"

FEEDERS, CONTINUOUS-WEIGHING

Merrick Scale Mfg. Co.—"FEEDO-WEIGHT"

FEEDERS, LIME, REAGENT, ETC.

B-I-F Industries, Inc., Omega Machine Co. Div.
Chain Belt Co.—"REX"
Denver Equipment Co.
Fischer & Porter Co.

Galigher Co.—"GEARY"
Jeffrey Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Morse Bros. Machinery Co.

FEEDERS, MINE-CAR

Fairmont Machinery Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Nolan Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

FEEDERS, RECIPROCATING

Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bartlett, C. O., & Snow Co.
B-I-F Industries, Inc., Omega Machine Co. Div.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
Continental Gin Co., Industrial Div.
Fairfield Engineering Co.
Fairmont Machinery Co.
Haiss Div., George, Pettibone, Mulliken Co.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Jeffrey Mfg. Co., Inc.
Kanawha Mfg. Co.
Kremser & Sons, Frank A.
Lecco Engrg. & Mfg. Co.—"LECCO VIB"
Link-Belt Co.—"LINK-BELT"
Lippmann Engineering Works
Marsh Engineering Co.
McLanahan & Stone Corp.
McNally Pittsburg Mfg. Corp.
Pioneer Engineering Works, Inc.
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Straub Mfg. Co., Inc.
Transall, Inc.
Traylor Engineering & Mfg. Co.
Universal Engineering Co.
Webb Corp.
WEMCO Div., Western Machinery Co.—"WEMCO"
Wilmot Engineering Co.

FEEDERS, VIBRATING

Fairfield Engineering Co.
Fairmont Machinery Co.
Goodman Mfg. Co.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Lecco Engrg. & Mfg. Co.—"LECCO VIB"
Link-Belt Co.—"LINK-BELT"
Marsh Engineering Co., E. F.
Ridge Equipment Co.
Simplicity Engineering Co.—"OS-A-VEY-OR"
Stephens-Adamson Mfg. Co.
Straub Mfg. Co., Inc.
Syntron Co.—"VIBRA-FLOW ELECTROMAGNETIC"
Transall, Inc.
Universal Engineering Co.
Webb Corp.

FEEDERS, VIBRATING GRIZZLY

Simplicity Engineering Co.

FENCING, METAL

American Steel & Wire Div., United States Steel Corp.—"AMERICAN"
Colorado Fuel & Iron Corp.—"C F & I, REALOCK"
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
Page Steel & Wire Div., American Chain & Cable Co., Inc.
Republic Steel Corp.—"REPUBLIC"
Sheffield Steel, Div., Armco Steel Corp.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"REALOCK"

FIFTH WHEELS

American Steel Foundries—"ASF EXTRA HEAVY DUTY"

FILES

Disston & Sons, Inc., Henry
Simonds Saw & Steel Co.—"RED TANG"

FILTER CLOTH, MEDIA

Cleveland Wire Cloth & Mfg. Co.
Colorado Fuel & Iron Corp.—"CAL-WIC"
Eimco Corp.
Fisher Scientific Co.
Johns-Manville Corp.—"CELITE"
Michigan Wire Cloth Co.
National Filter Media Corp.
Newark Wire Cloth Co.
Peterson Filters & Engineering Co.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"WISSCO"

FILTERS, AIR

American Air Filter Co., Inc.—"ELECTRO-MATIC," "ELECTRO-CELL," "ELECTRO-PL," "MULTI-DUTY," "ROLL-O-MATIC," "AIRMAT PL-24," "AMERICAN HV," "AMERGLAS"
Coppus Engineering Co.
Ducon Co.
Goodyear Tire & Rubber Co.
Kinney Engineers, Inc., S. P.
Lincoln Engineering Co.
Mine Safety Appliances Co.—"ULTRA-AIRE"
Victor Equipment Co.

FILTERS, DISC, DRUM, VACUUM

Denver Equipment Co.
Dorr-Oliver Incorporated—"AMERICAN," "OLIVER"
Eimco Corp.
Morse Bros. Machinery Co.
Peterson Filters & Engineering Co.
Whiting Corp.

FILTERS, HORIZONTAL

Bird Machine Co.

FILTERS, FIRE-RESISTANT FLUIDS

Marvel Engineering Co.

FILTERS, FUEL, HYDRAULIC & LUBE OILS

Compton, Inc.
Hydramotive, Inc.
Marvel Engineering Co.
Schroeder Brothers
U. S. Hoffman Machinery Corp.

FILTERS, WATER

Marvel Engineering Co.

FIRE TRUCKS, APPARATUS

Mack Motor Truck Corp.

FIRE BRICK

Johns-Manville Corp.
Mexico Refractories Co.—"JAY BEE," "MAXIMUL," "MO-REX," "AZTEX," "VIKING," "THOR," "M-26"

FIRE CARS, TRUCKS

Ansul Chemical Co.
Fyr-Fyter Co.

FIRE-EXTINGUISHER FLUIDS

American Chemsol Co.

FIRE EXTINGUISHERS

American LaFrance Corp.—"AMERICAN LA FRANCE"
Ansul Chemical Co.
Fisher Scientific Co.
Fyr-Fyter Co.
Graybar Electric Co., Inc.
Kidde & Co., Walter
National Mine Service Co.

FIRE HOSE, INDUSTRIAL

Boston Woven Hose & Rubber Co.

FIRE PROTECTION SYSTEMS

American LaFrance Corp.—"AMERICAN LA FRANCE"
Cardox Corp.
Grinnell Co.
Kidde & Co., Walter

FIRST-AID EQUIPMENT

Bullard Co., E. D.
Fisher Scientific Co.
General Scientific Equipment Co.
Mine Safety Appliances Co.—"ALL-WEATHER"
National Mine Service Co.

FITTINGS, CONDUIT, ELECTRICAL

Crouse-Hinds Co.—"CONDULET"

FITTINGS, GREASE

Lincoln Engineering Co.

FITTINGS, HOSE, DETACHABLE & REUSABLE

Aeroquip Corp.

FITTINGS & COUPLINGS, HOSE

Hose Accessories Co., Le-Hi Div.—"LE-HI"

FITTINGS, WIRE ROPE & CHAIN

American Hoist & Derrick Co.

FLAME SAFETY LAMPS

Mine Safety Appliances Co.
National Mine Service Co.—"KOEHLER"

FLASHLIGHTS, SAFETY & INDUSTRIAL

National Carbon Co., Div. Union Carbide & Carbon Corp.—"EVEREADY"

FLIGHTS, PLAIN, PERFORATED

Diamond Mfg. Co.

FLOAT & SINK STANDARD SOLUTIONS

American Chemsol Co.—"CERTIGRAV"

FLOAT-AND-SINK TESTERS

Commercial Testing & Engrg. Co.
Holmes & Bros., Inc., Robert

FLOAT-AND-SINK TESTERS, LABORATORY

WEMCO Div., Western Machinery Co.—"WEMCO," "HMS"

FLOCCULATING AGENTS

American Cyanamid Co., Mineral Dressing Dept.—"AEROFLOC"

FLOORING, GRATING

Dravo Corp.
Ryerson & Sons, Inc., Joseph T.
Smith Co., A. O.

FLOODLIGHTS

Crouse-Hinds Co.
Phoenix Metal Products—"STURDILITE"

FLOOR PLATE

United States Steel Corp.—"MULTIGRIP"

FLOOR RESURFACERS

Stonhard Co.—"STONPACH," "STONCAP," "STONFAST"

FLOTATION CONDITIONERS, FROTHERS, PUMPS, ETC.

Denver Equipment Corp.
Galigher Co.—"AGITAIR," "GALIGHER"
Morse Bros. Machinery Co.
WEMCO Div., Western Machinery Co.—"WEMCO"

FLOTATION MACHINES

American Well Works
Chain Belt Co.—"REX"
Denver Equipment Co.
Galigher Co.—"AGITAIR"
Morse Bros. Machinery Co.
WEMCO Div., Western Machinery Co.—"WEMCO-FAGERGREN"
Wilmot Engineering Co.

FLOTATION PLANTS, PORTABLE

Denver Equipment Co.

FLOTATION REAGENTS

American Chemsol Co.—"CHEMFROTH"
American Cyanamid Co., Mineral Dressing Dept.—"AEROFROTH"
Denver Equipment Co.
Dow Chemical Co.
Fisher Scientific Co.
General Mills, Inc.
Hercules Powder Co.
Michigan Alkali Div., Wyandotte Chemicals Corp.

FUEL-INJECTION EQUIPMENT

Kennedy Van Saun Mfg. & Engrg. Corp.

FLUMES, WOOD-STAVE

Michigan Pipe Co.

FREEZEPROOFING CHEMICALS

Morton Salt Co.—"FORMULA 5"

FURNACES, COMBUSTION

Hevi-Duty Electric Co.—"HEVI-DUTY"

FURNACES, DIRECT-FIRED WARM-AIR

Campbell Co., E. K.

FURNACES, HEAT-DRYING

Bigelow-Liptak Corp.
Combustion Engineering, Inc., Raymond Div.
Dorr-Oliver Incorporated—"FLUOSOLIDS"
Dravo Corp.
Kennedy Van Saun Mfg. & Engrg. Corp.
Reintjes Co., George P.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Westinghouse Electric Corp.

FURNACES, HEATING

Dallas Engineers, Inc., Coal-O-Matic Div.

FUSE, DETONATING

Atlas Powder Co.
duPont de Nemours & Co., E. I.
Ensign-Bickford Co.
Hercules Powder Co.
Illinois Powder Mfg. Co.
King Powder Co., Inc.
National Powder Co.
Olin Mathieson Chemical Corp.

FUSE, DETONATING, MILLISECOND CONNECTORS

duPont de Nemours & Co., E. I.
Hercules Powder Co.
Illinois Powder Mfg. Co.
King Powder Co., Inc.
National Powder Co.
Olin Mathieson Chemical Corp.

FUSE, SAFETY (BLASTING)

Ensign-Bickford Co.

FUSE HOLDERS

Bussman Mfg. Co.—"BUSS"
Federal Telephone & Radio Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Construction Materials Div.
Illinois Powder Mfg. Co.
King Powder Co., Inc.
Mosebach Electric & Supply Co.
Olin Mathieson Chemical Corp.

FUSE REDUCERS

Trico Fuse Mfg. Co.—"TRICO"

FUSES, ELECTRICAL

Bussmann Mfg. Co.—"FUSETRON, BUSS"
duPont de Nemours & Co., E. I.
Economy Fuse & Mfg. Co.
Ensign Electric & Mfg. Co.
Federal Telephone & Radio Co.
General Electric Co., Apparatus Sales Div.
Graybar Electric Co., Inc.
Illinois Powder Mfg. Co.
Mining Machine Parts, Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Trico Fuse Mfg. Co.—"KANTARK," "COLORTOP," "TRICO"

GAGES, TRACK, CENTER

Gibraltar Equipment & Mfg. Co.

GAGES, PRESSURE, VACUUM

B-I-F Industries, Inc., Builders-Providence Div.
Bristol Co.—"BRISTOL'S"
Fischer & Porter Co.
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Hays Corp.
Helicoid Gage Div., American Chain & Cable Co., Inc.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Victor Equipment Co.

GAS DETECTORS, MINE

Fisher Scientific Co.
Mine Safety Appliances Co.
National Mine Service Co.—"RIKEN"

GAS MASKS

General Scientific Equipment Co.
Mine Safety Appliances Co.—"ALL-SERVICE"
Willson Products, Inc.

GASKETS AND MATERIALS

Anchor Packing Co.
Garlock Packing Co.
Goodall Rubber Co.
Greene, Tweed & Co.—"PALMETTO"
Johns-Manville—"GOETZE," "SPIROTALLIC"
Magic Chemical Co.
Manhattan Rubber Div., Raybestos-Manhattan, Inc.
Quaker Rubber Corp. Div. of H. K. Porter, Inc., of Pittsburgh
McNally Pittsburg Mfg. Corp.
New York Belting & Packing Co.—"GREAT SEAL," "INDUSTRUCTIBLE"

GASKETS, RUBBER

Continental Rubber Works

GATES, BIN AND HOPPER

Bartlett, C. O., & Snow Co.

GEARMOTORS

Allis-Chalmers Mfg. Co.
Allis Co., Louis
Bonded Scale & Machine Co.
Brad-Foote Gear Works
Century Electric Co.—"CENTURY"
Christian Engineers, J. D.—"RITE LO SPEED"
Continental Electric Co.
Electric Dynamic Div., General Dynamics
Elliott Co.
Ensign Electric & Mfg. Co.
Fairbanks-Morse & Co.
Falk Corp.—"ALL-MOTOR"
Foote Bros. Gear & Machine Corp.—"FOOTE BROS.-LOUIS ALLIS"
Graybar Electric Co., Inc.
James Gear Mfg. Co., D. O.
Joy Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Mosebach Electric & Supply Co.
Pittsburgh Gear Co.
Reliance Electric & Engineering Co.
Savage Co., W. J.
Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co.
Westinghouse Electric Corp.
U. S. Electrical Motors, Inc.—"SYNCRO-GEAR"

GEARS

Cone-Drive Gears, Div. of Michigan Tool Co.

GEARS, PINIONS

American Manganese Steel Div., American Brake Shoe Co.
Brad-Foote Gear Works
Christian Engineers, J. D.
Cooke-Wilson Electric Supply Co.
Falk Corp.
Farrel-Birmingham Co., Inc.
Flood City Brass & Electric Co.
Foote Bros. Gear & Machine Corp.—"DUTI-RATED"
Herold Mfg. Co.
Holmes & Bros., Inc., Robert
James Gear Mfg. Co., D. O.
Jeffrey Mfg. Co.
Jones Foundry & Machine Co., W. A.
Kinney Engineers, Inc., S. P.
Link-Belt Co.—"LINK-BELT"
McNally Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
Pittsburgh Gear Co.
Tool Steel Gear & Pinion Co.
Tracy Co., Bertrand P.
Webster Mfg., Inc.
Westinghouse Electric Corp.
West Virginia Armature Co.
Wilmot Engineering Co.

GEARS, WORM

Cone-Drive Gears, Div. of Michigan Tool Co.

GEOPHYSICAL SURVEYS, AIRBORNE

Fairchild Aerial Surveys, Inc.

GLOVES

American Optical Co.
Bullard Co., E. D.
Continental Rubber Works
Fisher Scientific Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Mine Safety Appliances Co.
Pulmosan Safety Equipment Co.

GLOVES, RUBBER

United States Rubber Co., Mechanical Goods Div.

GOGGLE-CLEANING STATIONS

American Optical Co.

GOGGLES

American Optical Co.
Bausch & Lomb Optical Co.
Bullard Co., E. D.
Chicago Eye Shield Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Judsen Rubber Works, Inc.
Martindale Electric Co.
Mine Safety Appliances Co.
Pulmosan Safety Equipment Co.
Willson Products, Inc.—"COVER-MOR," "COVER-ALL"
United States Safety Service Co.

GRADER BLADES

Colorado Fuel & Iron Corp.—"CF&I"

GRADERS, MOTOR

Allis-Chalmers Mfg. Co.
Austin Western Co., Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Caterpillar Tractor Co.
Galion Iron Works & Mfg. Co.

Huber-Warco Co.
Pettibone Mulliken Corp.—"SPEEDGRADER"

GRATINGS, FLOOR

Hendrick Mfg. Co.

GREASE-LINE EXTENSIONS

Clarkson Mfg. Co.—"CLARKSON"

GRINDERS, BENCH & FLOOR

Black & Decker Mfg. Co.
Cincinnati Electrical Tool Co.
Fisher Scientific Co.
Ingersoll-Rand Co.
Martindale Electric Co.
Penn Machine Co.
Snap-On Tools Corp.—"BLUE-POINT"
Thor Power Tool Co.

GRINDERS, DISC

New Era Engineering Co.—"NEECO"

GRINDERS, PEDESTAL

South Bend Lathe Works

GRINDERS, PORTABLE

Black & Decker Mfg. Co.
Carboloy Dept., General Electric Co.
Chicago Pneumatic Tool Co.
Cleco Div., Reed Roller Bit Co.—"CLECO"
Martindale Electric Co.
Penn Machine Co.
Thor Power Tool Co.

GRINDING WHEELS

Manhattan Rubber Div., Raybestos-Manhattan, Inc.
Norton Co.—"ALUNDUM," "CRYSTOLON"
Snap-On Tools Corp.—"BLUE-POINT"
Thor Power Tool Co.

GRINDING WHEELS, DIAMOND

Hoffman Brothers Drilling Co.

GRIZZLY BARS AND GRIZZLIES

Phillips Div., Salem-Brosius, Inc.

GROUND CLAMPS

Erico Products, Inc.—"CADDY"
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Trico Fuse Mfg. Co.—"KLIPLOK"

GROUND CLAMPS, GROUND RODS

Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"

GROUND DETECTORS

Electrical Distributors Co.
General Electric Co., Apparatus Sales Div.
Joy Mfg. Co.
National Mine Service Co.—"N. M. S. GROUND SENTINEL"

GROUTING

Hoffman Bros. Drilling Co.

GROWLERS, ARMATURE

Complete Reading Electric Co., Inc.
Martindale Electric Co.
Snap-On Tools Corp.—"BLUE-POINT"

GUIDES, HAND-HELD CUTTING TORCHES

New Era Engineering Co.—"NEECO"

GUNITE WORK

Gunite Concrete & Construction Co.

GUNS, PNEUMATIC CONCRETE PLACING

Construction Machinery Co.

HACK-SAW, BAND-SAW BLADES

Simonds Saw & Steel Co.—"REDEND"

HAMMERS, AIR

Acme Machinery Co.
Chicago Pneumatic Tool Co.
Cleco Div., Reed Roller Bit Co.—"CLECO"
Davey Compressor Co.
Gardner-Denver Co.—"GARDNER-DENVER"
Ingersoll-Rand Co.
Joy Mfg. Co.
Penn Machine Co.
Thor Power Tool Co.

HAMMERS, REPLACEABLE SOFT-FACED

Greene, Tweed & Co.—"BASA"

HANDLES, TOOL

Gibraltar Equipment & Mfg. Co.
Marion Handle Mills, Inc.—"MARION"
Salem Tool Co.—"SALEM"
Wood Shovel & Tool Co.

HANGERS

American Pulley Co.

HANGERS, TROLLEY

Elreco Corp.

HARDFACING MATERIALS

Air Reduction Sales Co. Div., Air Reduction Co., Inc.
Alloy Rods Co.—"WEAR-ARC," "WEAR-FLAME," "SUPER WH"
American Manganese Steel Div., American Brake Shoe Co.
Carboloy Dept., General Electric Co.
Coast Metals, Inc.
Eutectic Welding Alloys Corp.—"EUTEC-RODS," "EUTECTRODES"
Haynes Stellite Co. Div., Union Carbide & Carbon Corp.
Lincoln Electric Co.—"HARDWELD," "ABRASOWELD," "MANGANWELD," "FACEWELD," "STAINWELD," "TONGWELD"
Sight Feed Generator Co.
Stoody Co.—"STOODY," "STIRRLITE"
Stulz-Sickles Co.—"MANGANAL," "SEACO"
Victor Equipment Co.
West Virginia Armature Co.

HEADLIGHTS

Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Jeffrey Mfg. Co.
National Mine Service Co.—"BEMECO LOCOLITE"
Schroeder Brothers

HEATERS, OIL

Hauck Mfg. Co.

HEATERS, SCREEN CLOTH

Deister Concentrator Co.—"FLEXELEX"

HEATERS, UNIT

American Air Filter Co., Inc.
American Blower Corp.—"VENTURAFIN"
Campbell Co., E. K.—"THERMIDAIRE"
Clarage Fan Co.
Dravo Corp.
General Electric Co., Apparatus Sales Div.
Graybar Electric Co., Inc.
Grinnell Co.
Ilg Electric Ventilating Co.
Westinghouse Electric Corp.
Wing Mfg. Co.—"WING REVOLVING"
Worthington Corp.

HEATING PLANTS

Campbell Co., E. K.—"THERMIDAIRE"
Canton Stoker Corp.
Combustion Engineering, Inc., Raymond Div.
Dallas Engineers, Inc., Coal-O-Matic Div.
Dravo Corp.

HEAVY-MEDIA RECLAMATION SYSTEMS

Denver Equipment Co.

HEAVY-MEDIA SEPARATION PROCESS

American Cyanamid Co., Mineral Dressing Dept.

HITCHINGS, MINE-CAR

National Malleable & Steel Casting Co.

HINGES, MINE DOOR

Clarkson Mfg. Co.—"CLARKSON"

HOIST CONTROLLERS

Allis-Chalmers Mfg. Co.
Clark Controller Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Joy Mfg. Co.

HOIST HOOKS

Upson-Walton Co.

HOIST SIGNALS

Mine Safety Appliances Co.—"HOISTPHONE"

HOISTS, CHAIN

Christian Engineers, J. D.
Coffing Hoist Co., Div. Duff-Norton Co.
Harnischfeger Corp.—"P & H"
Morse Bros. Machinery Co.
Robbins & Meyers, Inc.—"R & M"
Shaw Box Crane & Hoist Div., Manning, Maxwell & Moore, Inc.—"BUDGIT" "LOAD LIFTER"
Wright Hoist Div., American Chain & Cable Co., Inc.
Yale & Towne Mfg. Co.

HOISTS, ELECTRIC

Yale & Towne Mfg. Co.

HOISTS, ELECTRIC TRAVELING

Shepard Niles Hoist & Crane Corp.

HOISTS, LAYER-LOADING

Coffing Hoist Co., Div. Duff-Norton Co.
Holmes & Bros., Inc., Robert
Shaw Box Crane & Hoist Div., Manning, Maxwell & Moore, Inc.—"BUDGIT" "LOAD LIFTER"

HOISTS, LOADING-BOOM

Austin-Western Co., Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Coffing Hoist Co., Div. Duff-Norton Co.
Christian Engineers, J. D.
Harnischfeger Corp.—"P & H"
Morse Bros. Machinery Co.
Shaw Box Crane & Hoist Div., Manning, Maxwell & Moore, Inc.—"BUDGIT" "LOAD LIFTER"

HOISTS, MONORAIL

American Engineering Co.
Coffing Hoist Co., Div. Duff-Norton Co.
Harnischfeger Corp.—"P & H"
Robbins & Meyers, Inc.—"R & M"
Shaw Box Crane & Hoist Div., Manning, Maxwell & Moore, Inc.—"BUDGIT" "LOAD LIFTER"
Wright Hoist Div., American Chain & Cable Co., Inc.
Yale & Towne Mfg. Co.

HOISTS, PORTABLE

Austin-Western Co., Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Chicago Pneumatic Tool Co.
Coffing Hoist Div., Duff-Norton Co.
Denver Equipment Co.
Flood City Brass & Electric Co.
Gardner-Denver Co.—"GARDNER-DENVER"
Graybar Electric Co., Inc.

Harnischfeger Co.—"P & H"
Ingersoll-Rand Co.
Joy Mfg. Co.
Lug-All Co.
Robbins & Meyers, Inc.—"R & M"
Shaw Box Crane & Hoist Div., Manning, Maxwell & Moore, Inc.—"BUDGIT" "LOAD LIFTER"
Thor Power Tool Co.
Wright Hoist Div., American Chain & Cable Co., Inc.
Yale & Towne Mfg. Co.

HOISTS, SCRAPER

Sauerman Bros., Inc.
Vulcan Iron Works

HOISTS, SHAFT

Gardner-Denver Co.—"GARDNER-DENVER"
Holmes & Bros., Inc., Robert
Ingersoll-Rand Co.
Joy Mfg. Co.
Mayo Tunnel & Mine Equipment Co.—"KOEPE SYSTEM"
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Wellman Engineering Co.

HOISTS, SKIP

Bartlett, C. O., & Snow Co.
Fairfield Engineering Co.

HOISTS, SLOPE

Gardner-Denver Co.—"GARDNER-DENVER"
Holmes & Bros., Inc., Robert
Ingersoll-Rand Co.
Joy Mfg. Co.
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Wellman Engineering Co.

HOISTS, TRUCK-BODY

Commercial Shearing & Stamping, Inc.
Galion Allsteel Body Co.
Gar Wood Industries, Inc.
Hercules Steel Prods. Co.
Hockensmith Corp.—"PENN"
Heil Co.
Marion Metal Prods. Co.
Perfection Steel Body Co.
Robbins & Meyers, Inc.—"R & M"
Shaw Box Crane & Hoist Div., Manning, Maxwell & Moore, Inc.,—"BUDGIT," "LOAD LIFTER"

HOOKS

Duquesne Mine Supply Co.—"REDIPT"

HOPPERS

McNally Pittsburg Mfg. Corp.

HOPPERS, WEIGH

Construction Machinery Co.
Fairbanks-Morse & Co.
Holmes & Bros., Inc., Robert
Kanawha Mfg. Co.
Koehring Co.
Nolan Co.
Webb Corp.

HOSE, AIR

Cleveland Rock Drill Div., Westinghouse Air Brake Co.
Flexible Tubing Corp.
Howells Mining Drill Co.
Lincoln Engineering Co.
Rydin Railway Equip. Co.
U. S. Hoffman Machinery Corp.

HOSE, AIR, STEAM, GAS

Acme Machinery Co.
Aeroquip Corp.
Anchor Packing Co.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co.
Chicago Pneumatic Tool Co.
Cincinnati Rubber Mfg. Co.
Continental Rubber Works
Flood City Brass & Electric Co.
Gates Rubber Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co.
Hamilton Rubber Mfg. Corp.
Hewitt-Robins, Inc.—"AJAX," "CONSERVO," "HEWLITE," "MALTESE CROSS," "MONARCH," "SERVALL"
Manhattan Rubber Div., Raybestos-Manhattan, Inc.
New York Belting & Packing Co.—"MAGIC," "HY-TEST," "INDESTRUCTIBLE," "STERLING," "JUBILEE," "GREAT SEAL"
Quaker Rubber Corp., Div. of H. K. Porter Company, Inc. of Pittsburgh
Republic Rubber Div., Lee Rubber & Tire Corp.
Thermoid Co., Industrial Div.
Thor Power Tool Co.
U. S. Rubber Co., Mechanical Goods Div.
Victor Equipment Co.

HOSE, FIRE & WATER

Anchor Packing Co.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co.
Cincinnati Rubber Mfg. Co.
Continental Rubber Works
Flood City Brass & Electric Co.
Fyr-Fyter Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co.
Hewitt-Robbins, Inc.—"AJAX," "CONSERVO," "HEWLITE," "MALTESE CROSS," "MONARCH," "SERVALL"
New York Belting & Packing Co.—"AFMIC," "STERLING," "JUBILEE"
Quaker Rubber Corp., Div. of H. K. Porter Company, Inc. of Pittsburgh
Republic Rubber Div., Lee Rubber & Tire Corp.
Thermoid Co., Industrial Div.
U. S. Rubber Co., Mechanical Goods Div.

HOSE, FLEXIBLE

Aeroquip Corp.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co.
Cincinnati Rubber Mfg. Co.
Cobra Metal Hose Div., D. K. Mfg. Co.—"COBRA" Seamless Metal
Compton, Inc.
Continental Rubber Works
Dayton Rubber Co.—"DAYTLEX," "DAYTON"
Flexible Tubing Corp.—"SPIRATUBE"
Flood City Brass & Electric Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co., Inc.
Hamilton Rubber Mfg. Corp.
Hewitt-Robbins, Inc.—"AJAX," "CONSERVO," "HEWLITE," "MALTESE CROSS," "MONARCH," "SERVALL"
Linatex Corp. of America
Lincoln Engineering Co.
New York Belting & Packing Co. —"MAGIC," "HY-TEST," "INDESTRUCTIBLE," "STERLING," "JUBILEE," "GREAT SEAL"
Quaker Rubber Corp., Div. of H. K. Porter Company, Inc. of Pittsburgh
Republic Rubber Div., Lee Rubber & Tire Corp.
Thermoid Co., Industrial Div.
U. S. Rubber Co., Mechanical Goods Div.

HOSE, FLEXIBLE, MINE

American Brattice Cloth Corp.

HOSE, GREASE & OIL

Lincoln Engineering Co.

HOSE, SUCTION, DISCHARGE

Boston Woven Hose & Rubber Co.
Carlyle Rubber Co.
Cincinnati Rubber Mfg. Co.
Continental Rubber Works
Failing Co., George E.
Flexible Tubing Corp.—"SPIRATUBE"
Flood City Brass & Electric Co.
Gates Rubber Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co., Inc.
Hamilton Rubber Mfg. Corp.
Hewitt-Robins, Inc.—"AJAX," "CONSERVO," "HEWLITE," "MALTESE CROSS," "MONARCH," "SERVALL"
New York Belting & Packing Co.—"DOUBLE DIAMOND," "NYB&P," "GREAT SEAL," "PARA"
Quaker Rubber Corp., Div. of H. K. Porter Company, Inc. of Pittsburgh
Republic Rubber Div., Lee Rubber & Tire Corp.
Thermoid Co., Industrial Div.
U. S. Rubber Co., Mechanical Goods Div.

HOSE, WATER

Gates Rubber Co.

HYDRAULIC CYLINDERS

Blackhawk Mfg. Co.
Cash Co., A. W. —"CASH STANDARD"
Commercial Shearing & Stamping, Inc.
Failing Co., George E.
Galion Allsteel Body Co.
Gar Wood Industries, Inc.
Hercules Steel Products Co.
Hydramotive, Inc.
Joy Mfg. Co.
New York Air Brake Company, The—"HYDRECO," "DUDEO"
Perfection Steel Body Co.
Star Jack Co., Inc.
Vickers, Inc.
Wellman Engineering Co.

HYDRAULIC FLUIDS, FIRE-RESISTANT

Monsanto Chemical Co., Organic Chemicals Div.

HYDRAULIC HOSE AND FITTINGS

Aeroquip Corp.
Blackhawk Mfg. Co.
Carlyle Rubber Co.
Champ Industries, Div. of Hose Accessories Co.
Compton, Inc.
Continental Rubber Works
Gates Rubber Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Hamilton Rubber Mfg. Corp.
Joy Mfg. Co.—"SURGEPRUF"
Lee-Norse Co.
Lincoln Engineering Co.
National Mine Service Co.
Quaker Rubber Corp., Div. of H. K. Porter Company, Inc. of Pittsburgh
Tamping Bag Co.
Thermoid Co., Industrial Div.
U. S. Rubber Co., Mechanical Goods Div.
Weatherhead Co.

HYDRAULIC PUMPS

American Engineering Co.
Berry Div., Oliver Iron & Steel Corp.—"BERRY"
Blackhawk Mfg. Co.
Commercial Shearing & Stamping, Inc.
Compton, Inc.
Dorr-Oliver Incorporated
Failing Co., George E.
Gar Wood Industries, Inc.
Hydramotive, Inc.
Joy Mfg. Co.

New York Air Brake Company, The—"HYDRECO," "DUDEO"
Star Jack Co., Inc.
Vickers, Inc.
Worthington Corp.

HYDAULIC PUMPS, REBUILDING
National Mine Service Co.

HYDRAULIC PUMPS, REPAIR
West Virginia Armature Co.

HYDRAULIC VALVES
Lunkenheimer Co.

HYDRAULIC VALVES, ACCESSORIES
Blackhawk Mfg. Co.
Cash Co., A. W.—"CASH STANDARD"
Cash Valve Mfg. Co., A. W.
Commercial Shearing & Stamping, Inc.
Darling Valve & Mfg. Co.
Gar Wood Industries, Inc.
Hydramotive, Inc.
Joy Mfg. Co.
New York Air Brake Company, The—"HYDRECO," "DUDEO"
Star Jack Co., Inc.
Vickers, Inc.
Wellman Engineering Co.

HYDROSEPARATORS
Dorr-Oliver Incorporated
WEMCO Div., Western Machinery Co.—"WEMCO"

INDICATORS, DATA DISPLAY, TRANSFER
Union Switch & Signal Div., Westinghouse Air Brake Co.

INDICATORS, REMOTE
Femco, Inc.

INSTRUMENTS, BLASTING VIBRATION
Vibration Measurement Engineers

INSTRUMENTS, RECORDING, PRESSURE, TEMPERATURE, ETC.
Baldwin-Lima-Hamilton Corp.
B-I-F Industries, Inc., Builders-Providence Div.—"CHRONOFLO," "FLO-WATCH"
Bristol Co.—"BRISTOL'S"
Failing Co., George E.
Fischer & Porter Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Hays Corp.
Helicoid Gage Div., American Chain & Cable Co., Inc.
Mine Safety Appliances Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Westinghouse Electric Corp.
West Instrument Corp.

INSTRUMENTS, ROOF CONTROL
Herold Mfg. Co.

INSULATED "J" HOOKS
Elreco Corp.

INSULATING MATERIAL, ELECTRIC
Complete Reading Electric Co., Inc.
Dow Corning Corp.
Johns-Manville Corp.
Kerite Co.
Mica Insulator Co.
duPont de Nemours & Co., Inc., E. I.—"MYLAR"
National Electric Coil Co.
Ohio Brass Co.
Pennsylvania Electric Coil Corp.
Plymouth Rubber Co., Inc.
Ruberoid Co.
Westinghouse Electric Corp.
West Virginia Armature Co.

INSULATION, MINERAL-WOOL
U. S. Pipe & Foundry Co.

INSULATION, PIPING, EQUIPMENT
Pittsburgh Corning Corp.

INSULATORS, ELECTRIC
Delta-Star Electric Div., H. K. Porter Company, Inc., of Pittsburgh
Elreco Corp.
Graybar Electric Co., Inc.
Ohio Brass Co.

INSURANCE
Bituminous Casualty Co.
Old Republic Insurance Co.

INSURANCE, PLANT & EQUIPMENT
Pfister Co., Inc., J. B.

INSURANCE, WORKMEN'S COMPENSATION
Old Republic Insurance Co.

JACK PIPE
Duquesne Mine Supply Co.

JACKS, AIR OPERATED
Joyce Cridland Co.

JACKS, GEARED
Templeton, Kenly & Co.

JACKS, HYDRAULIC
Allis-Chalmers Mfg. Co., Buda Div.
Blackhawk Mfg. Co.
Commercial Shearing & Stamping, Inc.
Duff-Norton Co.
Graybar Electric Co., Inc.
Joyce Cridland Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
Porter, Inc., H. K.—"P-F PORTER-FERGUSON"
Star Jack Co., Inc.
Templeton, Kenly & Co.

JACKS, LIFTING
Allis-Chalmers Mfg. Co., Buda Div.
Blackhawk Mfg. Co.
Duff-Norton Co.
Graybar Electric Co., Inc.
Joyce Cridland Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"TOE WF"
Tracy Co., Bertrand P.

JACKS, MECHANICAL
Templeton, Kenly & Co.

JACKS, PULLING
Blackhawk Mfg. Co.
Duff-Norton Co.
Graybar Electric Co., Inc.
Joyce Cridland Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Nolan Co.
Star Jack Co., Inc.

JACKS, PUSH & PULL
Gibraltar Equipment & Mfg. Co.

JACKS, PUSH & PULL, MAINTENANCE
Templeton, Kenly & Co.—"UTIL-A-TOOL"

JACKS, RATCHET LOWERING
Templeton, Kenly & Co.

JACKS, ROOF
Duff-Norton Co.
Herold Mfg. Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
Star Jack Co., Inc.
Templeton, Kenly & Co.

JACKS, ROOF HYDRAULIC
Dowty Mining Equipment

JACKS, SCREW
Templeton, Kenly & Co.

JACKS, TIMBERING
Duff-Norton Co.
Herold Mfg. Co.
Mosebach Electric & Supply Co.
Star Jack Co., Inc.
Templeton Kenly & Co.

JIGS, PYRITE RECOVERY
Denver Equipment Co.

JOINTS, RUBBER EXPANSION
Garlock Packing Co.

JOINTS, UNIVERSAL
Galion Allsteel Body Co.
Herold Mfg. Co.
Lovejoy Flexible Coupling Co.

JOURNAL BEARINGS, BRONZE
American Crucible Products Co.

JOURNALS, BOXES
Chain Belt Co.—"REX"
Flood City Brass & Electric Co.
Holmes & Bros., Inc., Robert
Hyatt Bearings Div., General Motors Corp.
Ironton Engine Co.
Jeffrey Mfg. Co.
Imperial-Cantrell Mfg. Co.
McNally Pittsburg Mfg. Corp.
National Mine Service Co.—"BEMECO"
West Virginia Armature Co.

JUNCTION BOXES, ELECTRIC
Crouse-Hinds Co.
Ensign Electric & Mfg. Co.
Graybar Electric Co., Inc.
Holmes & Bros., Inc., Robert
Joy Mfg. Co.
National Electric Products Co.
Ohio Brass Co.

KEY SEATERS
Gibraltar Equipment & Mfg. Co.

KNEE PADS
General Scientific Equipment Co.
Howells Mining Drill Co.
Industrial Rubber Products Co.
Judsen Rubber Works, Inc.—"JUDSEN"
Mine Safety Appliances Co.
Salem Tool Co.

LABORATORY CRUSHERS
Universal Engineering Co., Dept. CA

LABORATORY EQUIPMENT
Bausch & Lomb Optical Co.
Central Scientific Co.
Denver Equipment Co.
Federal Telephone & Radio Co.
Fischer & Porter Co.
Fisher Scientific Co.
Galigher Co.—"GALIGHER"
General Scientific Equipment Co.
Hoffman Bros. Drilling Co.
Holmes & Bros., Inc., Robert
Laboratory Equipment Corp.
Mine & Smelter Supply Co.
Sturtevant Mill Co.
WEMCO Div., Western Machinery Co.—"WEMCO"

LABORATORY FLOTATION
Denver Equipment Co.

LABORATORY FLOTATION MACHINES
Galigher Co.—"AGITAIR"

LABORATORY FURNACES
Hevi-Duty Electric Co.—"HEVI-DUTY"

LABORATORY TESTING
Denver Equipment Co.
WEMCO Div., Western Machinery Co.

LACING, BELT
Armstrong-Bray Co.

LAMPS, PICKING
General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Mosebach Electric & Supply Co.

LARRIES
Atlas Car & Mfg. Co.
Chain Belt Co.—"REX"
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Fairfield Engineering Co.
Jeffrey Mfg. Co.
Link-Belt Co.—"LINK-BELT"

LARRIES, WEIGH
Bartlett, C. O., & Snow Co.

LATHES
South Bend Lathe Works

LEVELS, ENGINEER
Berger, C. L., & Sons, Inc.
Brunson Instrument Co.

LEVEL CONTROLS
Cash Co., A. W.

LIGHTING, FIXTURES
American Mine Supply Co.
Crouse-Hinds Co.
Graybar Electric Co., Inc.
National Mine Service Co.
Welch Electric Co.

LIGHTING FIXTURES, UNDERGROUND
Mine Safety Appliances Co.

LIGHTNING ARRESTERS
General Electric Co., Apparatus Sales Div.
Graybar Electric Co., Inc.
Ohio Brass Co.
Westinghouse Electric Corp.

LINER PLATE
McNally Pittsburg Mfg. Corp.

LINER PLATE, SHAFT & TUNNEL
Commercial Shearing & Stamping, Inc.
Kanawha Mfg. Co.
Mahon Co., R. C.
Taylor-Wharton Iron & Steel Co.

LININGS, CHUTE
American Brake Shoe Co.
Thermoid Co., Industrial Div.

LININGS, CHUTE & TANK, GLASS
Kanawha Mfg. Co.

LININGS, CHUTE & TANK, METAL
Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Kanawha Mfg. Co.
McNally Pittsburg Mfg. Corp.
Quaker Rubber Corp., Div. of H. K. Porter Company, Inc., of Pittsburgh
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Taylor-Wharton Iron & Steel Co.
Webb Corp.

LININGS, CHUTE & TANK, RUBBER
Fairmont Machinery Co.
Galigher Co.—"GALIGHER"
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co., Inc.
Linatex Corp. of America
Magic Chemical Co.
New York Belting & Packing Co.—"KARBONITE"
Republic Rubber Div., Lee Rubber & Tire Corp.
U. S. Rubber Co., Mechanical Goods Div.

LININGS, CONCRETE
Gunite Concrete & Construction Co.

LININGS, FURNACE
Reintjes Co., George P.

LIQUID OXYGEN
Air Reduction Sales Co. Div., Air Reduction Co., Inc.
Linde Air Products Co., Div. Union Carbide & Carbon Corp.

LIQUID-OXYGEN EXPLOSIVES
Airmite-Midwest, Inc.—"AIRMITE"

LOADING BOOMS, APRON
Bartlett, C. O., & Snow Co.
Chain Belt Co.—"REX"
Fairmont Machinery Co.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
McNally Pittsburg Mfg. Corp.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Webb Corp.
Webster Mfg., Inc.

LOADING BOOMS, BELT
Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
Davis Co., Nelson L.
Hewitt-Robins, Inc.
Heyl & Patterson, Inc.
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Lippmann Engineering Works
Link-Belt Co.—"LINK-BELT"
McNally Pittsburg Mfg. Corp.
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Webb Corp.
Webster Mfg., Inc.

LOADING BOOMS, CHAIN
McNally Pittsburg Mfg. Corp.

LOADING BOOMS, CHAIN, RESCREENING
Davis Co., Nelson L.
Fairmont Machinery Co.
Holmes & Bros., Inc., Robert
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Transall, Inc.
Webb Corp.

LOADING MACHINE CHECKS
Daly Ticket Co.—"DALY'S"

LOADING MACHINES, CRAWLER
American Tractor Corp.—"TERRATRAC"
Barber-Greene Co.
Bucyrus-Erie Co.
Galion Allsteel Body Co.
Haiss Div., George, Pettibone Mulliken Corp.
Harnischfeger Corp.—"P&H"
Morse Bros. Machinery Co.
Oliver Corp.
Pettibone Mulliken Corp.—"SPEEDALL," "SPEEDSWING"
Tractomotive Corp.—"TRACTO-LOADERS"

LOADING MACHINES, RUBBER-TIRED
Barber-Greene Co.
Bucyrus-Erie Co.
Construction Machinery Div., Clark Equipment Co.
Eimco Corp., The
Harnischfeger Corp.—"P&H"
Hough Co., Frank G.

LOADING MACHINES, UNDERGROUND, CRAWLER
Eimco Corp.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Lee-Norse Co.
Long Co.—"PIGLOADER"
Myers-Whaley Co.—"WHALEY AUTOMAT"

LOADING MACHINES, UNDERGROUND, RUBBER-TIRED
Clarkson Mfg. Co.—"CLARKSON REDBIRD"
Jeffrey Mfg. Co.

LOADING MACHINES, UNDERGROUND, CONVERTED, TRACK TO RUBBER
Lee-Norse Co.

LOADING MACHINES, UNDERGROUND, TRACK
Clarkson Mfg. Co.—"CLARKSON REDBIRD"
Eimco Corp.
Gardner-Denver Co.—"GARDNER-DENVER"
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Morse Bros. Machinery Co.
Myers-Whaley Co.—"WHALEY AUTOMAT"

LOCKERS
Moore Co.

LOCK NUTS
Elastic Stop Nut Corp. of America

LOCOMOTIVES, BATTERY
Atlas Car & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Goodman Mfg. Co.
Greensburg Machinery Co.
Ironton Engine Co.
Jeffrey Mfg. Co.
Kersey Mfg. Co., Inc.
Morse Bros. Machinery Co.
Vulcan Iron Works

LOCOMOTIVES, DIESEL
Baldwin-Lima-Hamilton Corp.
Brookville Locomotive Works
Davenport Besler Corp.
Diesel Energy Corp.
Eimco Corp.
Goodman Mfg. Co.
Mayo Tunnel & Mine Equipment Co.
National Mine Service Co.—"NATIONAL MINE SERVICE"
Plymouth Locomotive Works, Div. of The Fate-Roote-Heath Co.—"MINE-O-MOTIVES"
Vulcan Iron Works

LOCOMOTIVES, DIESEL-ELECTRIC
General Electric Co., Apparatus Sales Div.

LOCOMOTIVES, TROLLEY
Differential Steel Car Co.

LOCOMOTIVES, TROLLEY, CABLE-REEL
General Electric Co., Apparatus Sales Div.
Goodman Mfg. Co.
Ironton Engine Co.
Jeffrey Mfg. Co.
Morse Bros. Machinery Co.
Vulcan Iron Works
Westinghouse Electric Corp.
West Virginia Armature Co.

LUBRICANTS

Alemite Div. of Stewart-Warner Corp.
American Oil Co.
Ashland Oil & Refining Co.—"ASHLAND"
Bearings, Inc.
Brooks Oil Co.
Carbide & Carbon Chemical Co., Div. Union Carbide & Carbon Corp.
Cities Service Oil Cos.
D-A Lubricant Co., Inc.—"D-A LUBRICANTS"
Dixon Crucible Co., Joseph
Dow Corning Corp.
Esso Standard Oil Co.
Gulf Oil Corp., Gulf Refining Co.
Homestead Valve Mfg. Co.
Houghton & Co., E. F.—"STA-PUTS," "COSMOLUBES"
Hulburt Oil & Grease Co.
Jesco Lubricants Co.—"JESCO"
Keystone Lubricating Co.
Lubriplate Div., Fiske Bros. Refining Co.
Ohio Oil Co.
Pennsylvania Refining Co.—"PENN," "DRAKE"
Pure Oil Co.
Shell Oil Co.
Sinclair Refining Co.
Socony Mobil Oil Co.—"DTE OILS," "VISCOLITES," "GARGOYLE"
South Bend Lathe Works
Standard Oil Co. (Indiana)
Sun Oil Co.
Swan-Finch Oil Corp.—"MOTUL & SAFCO HEAVY-DUTY"
Texas Co.
Tide Water Associated Oil Co.
Valvoline Oil Co., Div. of Ashland Oil & Refining Co.—"VALVOLINE"
Warren Refining & Chemical Co.—"PLASTILUBE," "BUSTRUX," "PLASTIGEAR," "GREEN GOLD," "WARLO," "STAYSIN," "THERMAX," "LITHOLUBE"
Whitmore Mfg. Co.

LUBRICATING FITTINGS

Alemite Div., Stewart-Warner Corp.
Gray & Co., Inc.
Keystone Lubricating Co.
Lincoln Engineering Co.

LUBRICATING GUNS

Alemite Div., Stewart-Warner Corp.
Gray & Co., Inc.
Homestead Valve Mfg. Co.
Lincoln Engineering Co.
Schroeder Brothers—"HYDRA-LUBER"
Trico Fuse Mfg. Co.—"REDI-PUMP"

LUBRICATING SYSTEMS, AUTOMATIC

Alemite Div., Stewart-Warner Corp.
Bowser, Inc.
Farval Corp.
Lincoln Engineering Co.
National Mine Service Co.
Trabon Eng. Co.
Trico Fuse Mfg. Co.—"OPTO-MATIC," "CENTURY," "VARI-FEED"
Victor Equipment Co.

LUBRICATING SYSTEMS, CENTRALIZED

Farval Corp.
Lincoln Engineering Co.

LUBRICATORS, TROLLEY-WIRE

Ohio Brass Co.

MACHINE GUARDS, PARTS FOR

Harrington & King Perforating Co.

MAGNET WIRE

General Electric Co., Construction Materials Dept.—"ALKANEX," "DELTA-BESTON," "FORMEX"

MAGNETIZING BLOCKS

Dings Magnetic Separator Co.

MAGNETITE

Daniels Co., Contractors, Inc.
Orefraction, Inc.

MAGNETITE RECOVERY, DENSIFIERS

Mine & Smelter Supply Co.—"AKINS"
WEMCO Div., Western Machinery Co.—"WEMCO"

MAGNETITE RECOVERY, SEPARATORS

Daniels Co., Contractors, Inc.
Dings Magnetic Separator Co.
Jeffrey Mfg. Co.
Magnetic Engineering & Mfg. Co.
Mine & Smelter Supply Co.—"AKINS"
Stearns Magnetic, Inc.

MAGNETS, CHUTE TYPE

Carboloy Dept., General Electric Co.
Dings Magnetic Separator Co.
Electric Controller & Mfg. Co.
Homer Mfg. Co., Inc.
Magnetic Engineering & Mfg. Co.
Savage Co., W. J.
Sprout, Waldron & Co., Inc.
Stearns Magnetic, Inc.
West Virginia Armature Co.

MAGNETS, LIFTING

Dings Magnetic Separator Co.

MAGNETS, PERMANENT, NON-ELECTRIC, CHUTE, PULLEY, SUSPENDED

Eriez Mfg. Co.

MAGNETS, PULLEY TYPE

Austin Western Co., Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Carboloy Dept., General Electric Co.
Cutler-Hammer, Inc.
Dings Magnetic Separator Co.
Homer Mfg. Co., Inc.
Magnetic Engineering & Mfg. Co.
Savage Co., W. J.
Stearns Magnetic, Inc.

MAGNETS, SUSPENDED

Dings Magnetic Separator Co.
Electric Controller & Mfg. Co.
Homer Mfg. Co., Inc.
Magnetic Engineering & Mfg. Co.
Savage Co., W. J.
Stearns Magnetic, Inc.

MALLETS

Greene, Tweed & Co.—"EMPIRE"

METALLIZING EQUIPMENT

Metallizing Engineering Co., Inc.—"METCO"

METERS, ELECTRICAL

B-I-F Industries, Inc., Builders-Providence Div.
Bristol Co.—"BRISTOL'S"
Fischer & Porter Co.
General Electric Co., Apparatus Sales Div.
Graybar Electric Co., Inc.
Martindale Electric Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Westinghouse Electric Corp.

MICROSCOPES

Bausch & Lomb Optical Co.

MILLS, BOWL, IMPACT, SCREEN, VERTICAL

Combustion Engineering Co., Raymond Div.

MILLS, LABORATORY

American Pulverizer Co.

MOILS

Howells Mining Drill Co.

MOISTURE METERS

Bristol Co.—"BRISTOL'S"
Central Scientific Co.
Heyl & Patterson, Inc.—"OLIVO"
Minneapolis-Honeywell Regulator Co., Industrial Div.

MORTAR, REFRACTORY

Mexico Refractories Co.—"LOSET," "HYSET," "MEX-R-CO"

MOTOR CONTROLLERS, STARTERS

Allen-Bradley Co.
Allis-Chalmers Mfg. Co.
Arrow Hart & Hegeman Electric Co.
Christian Engineers, J. D.
Clark Controller Co.
Crouse-Hinds Co.
Cutler-Hammer, Inc.
Electro Dynamic Div., General Dynamics
Electric Machinery Mfg. Co.
General Electric Co., Apparatus Sales Div.
Graybar Electric Co., Inc.
Guyan Machinery Co.
Harnischfeger Corp.—"P&H"
Ironton Engine Co.
Joy Mfg. Co.
National Mine Service Co.
Ohio Brass Co.
Savage Co., W. J.
Square D Co.
Westinghouse Electric Corp.

MOTOR-GENERATOR SETS

Air Reduction Sales Co. Div., Air Reduction Co., Inc.
Allis-Chalmers Mfg. Co.
Allis Co., Louis
Century Electric Co.—"CENTURY"
Continental Electric Co.
Electro Dynamic Div., General Dynamics
Elliott Co.
Electric Products Co.
Ensign Electric & Mfg. Co.
Fairbanks-Morse & Co.
General Electric Co., Apparatus Sales Div.
Graybar Electric Co., Inc.
Harnischfeger Corp.—"P&H"
Hobart Bros.—"HOBART"
Homelite Corp.—"HOMELITE"
Ironton Engine Co.
Leland Electric Co. Div., American Machine & Foundry Co.
National Mine Service Co.
Reeves Pulley Co.
Reliance Electric & Engineering Co.
Robbins & Meyers, Inc.—"R&M," "ALL-WEATHER"
Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co.
Westinghouse Electric Corp.

MOTORS, AC

Acme Machinery Co.
Allis-Chalmers Mfg. Co.
Allis Co., Louis
Bonded Scale & Machine Co.
Century Electric Co.—"CENTURY"
Christian Engineers, J. D.
Continental Electric Co.
Electro Dynamic Div., General Dynamics
Electric Machinery Mfg. Co.
Electric Products Co.
Elliott Co.
Ensign Electric & Mfg. Co.
Fairbanks-Morse & Co.
General Electric Co., Apparatus Sales Div.
Graybar Electric Co., Inc.
Harnischfeger Corp.
Joy Mfg. Co.
Leland Electric Co. Div., American Machine & Foundry Co.
Lewis Industries, Ltd.
Mosebach Electric & Supply Co.
National Mine Service Co.
Reeves Pulley Co.
Reliance Electric & Engineering Co.
Robbins & Meyers, Inc.—"R&M," "ALL-WEATHER"
Savage Co., W. J.
Smith Co., A. O.

Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co.
U. S. Electrical Motors, Inc.—"UNICLOSED," "VARIDRIVE," "SYNCROGEAR"
Wagner Electric Corp.
Westinghouse Electric Co.
West Virginia Armature Co.

MOTORS, DC

Acme Machinery Co.
Allis-Chalmers Mfg. Co.
Allis Co., Louis
Bonded Scale & Machine Co.
Century Electric Co.—"CENTURY"
Christian Engineers, J. D.
Continental Electric Co.
Electro Dynamic Div., General Dynamics
Elliott Co.
Ensign Electric & Mfg. Co.
Fairbanks-Morse & Co.
General Electric Co., Apparatus Sales Div.
Graybar Electric Co., Inc.
Harnischfeger Corp.—"P&H"
Ironton Engine Co.
Joy Mfg. Co.
Leland Electric Co. Div., American Machine & Foundry Co.
Lewis Industries, Ltd.
Mosebach Electric & Supply Co.
National Mine Service Co.
Reeves Pulley Co.
Reliance Electric & Engineering Co.
Robbins & Meyers, Inc.—"R&M," "ALL-WEATHER"
Smith Co., A. O.
Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co.
Westinghouse Electric Corp.
West Virginia Armature Co.

MOTORS, AIR

Eimco Corp.
Gardner-Denver Co.
Herold Mfg. Co.
Joy Mfg. Co.

MOTORS, FLUID

Berry Div., Oliver Iron & Steel Corp.—"BERRY"

MOTORS, REWINDING, REPAIRS

Flood City Brass & Electric Co.
Guyan Machinery Co.
Hannon & Sons, F. A.
Industrial Machine & Electric Co.
Mertindale Electric Co.
National Electric Coil Co.
Pennsylvania Electric Coil Corp.
Wagner Electric Co.
Westinghouse Electric Corp.
West Virginia Armature Co.

NIPS, FUSED

Elreco Corp.
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Brass Co.

NOZZLES, FOG AND SPRAY

Bete Fog Nozzle, Inc.
Chain Belt Co.—"REX"
Deister Machine Co.
Grinnell Co., Inc.—"PROTECTO SPRAY"
Johnson-March Corp.
Kinney Engineers, Inc., S. P.
Savage Co., W. J.
Victor Equipment Co.
West Virginia Armature Co.

NOZZLES, SPRAY

Deister Concentrator Co.—"CONCENCO"
Link-Belt Co.
Worthington Corp.

OVENS, BAKING

Complete Reading Electric Co., Inc.
Fischer Scientific Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
U. S. Hoffman Machinery Corp.

OVERCASTS, STEEL DEMOUNTABLE

Tri-County Building Service

OXYGEN-ADMINISTERING EQUIPMENT

Mine Safety Appliances Co.

OXYGEN-BREATHING APPARATUS

Bullard Co., E. D.
Linde Air Products Co., Div. Union Carbide & Carbon Corp.
Mine Safety Appliances Co.—"CHEMOX," "MCCAA"

PACKING

Anchor Packing Co.
Boston Woven Hose & Rubber Co.
Garlock Packing Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Houghton & Co., E. F.—"JIM," "JIX-SYN"
Johns-Manville Corp.—"MOGUL," "SERVICE," "CHEMPAC," "SEA RINGS," "KEARSAGE," "CENTRIPAC," "NAVALON"
Manhattan Rubber Div., Raybestos-Manhattan, Inc.
New York Belting & Packing Co.—"GREAT SEAL," "INDESTRUCTIBLE," "FIRO"
Republic Rubber Div., Lee Rubber & Tire Corp.
Thermoid Co., Industrial Div.

PACKING, MECHANICAL

Greene, Tweed & Co.—"PALMETTO," "PALCO," "PELRO," "KLERO," "CUTNO," "SUPER CUTNO," "9-TRING," "PYRAMID," "KUP"

PACKING, SHEET

Hewitt-Robins, Inc.—"CONSERVO," "MONARCH," "AJAX"

PACKING, RUBBER

Hamilton Rubber Mfg. Corp.
United States Rubber Co., Mechanical Goods Div.

PAINTS

Steelcote Mfg. Co.

PAINTS, ALUMINUM

Master Bronze Powder Co.—"BROMA," "DERUSTO"
U. S. Pipe & Foundry Co.

PAINTS, ANTICORROSIVE

Stonhard Co.

PAINTS, REFLECTIVE

Stonhard Co.

PANELBOARDS

Crouse-Hinds Co.

PARTS, LOCOMOTIVE

Flood City Brass & Electric Co.
Goodman Mfg. Co.
Industrial Machine & Electric Co.
Ironton Engine Co.
Jeffrey Machine Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
Tracy Co., Bertrand P.
West Virginia Armature Co.

PARTS, MINING MACHINERY

American Manganese Steel Div., American Brake Shoe Co.
American Steel Foundries—"WEARPACT"
Brad-Foote Gear Works
Clarkson Mfg. Co.—"CLARKSON"
Cooke-Wilson Electric Supply Co.
Flood City Brass & Electric Co.
Goodman Mfg. Co.
Herold Mfg. Co.
Industrial Machine & Electric Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Mining Machine Parts, Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
Pittsburgh Gear Co.
Tracy Co., Bertrand P.
West Virginia Armature Co.

PARTS, MOTORS

Complete Reading Electric Co., Inc.
Industrial Machine & Electric Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
National Mine Service Co.
Tracy Co., Bertrand P.
West Virginia Armature Co.

PARTS, SHUTTLE CARS

Tracy Co., Bertrand P.

PARTS, TRUCK

Cline Truck Co.
Mack Motor Truck Corp.

PH INDICATORS

Bristol Co.—"BRISTOLS"
Central Scientific Co.
Denver Equipment Co.
Fischer Scientific Co.
Foxboro Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.

PHOTOGEOLOGY

Longyear Co., E. J.

PICKING TABLES

Bonded Scale & Machine Co.—"BONDED"
Connellsville Mfg. & Mine Supply Co.
Fairmont Machinery Co.
Jeffrey Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co.—"LINK-BELT"
Marsh Engineering Co., E. F.
McNally Pittsburg Mfg. Corp.
Ridge Equipment Co.
Roberts & Schaefer Co., Sub. Thompson-Starret Co., Inc.
Stephens-Adamson Mfg. Co.
Syntron Co.
Transall, Inc.
Webb Corp.
Wilmot Engineering Co.

PICKS

Bowdil Co.
Salem Tool Co.—"SALEM"

PILLOW BLOCKS

Ahlberg Bearing Co.
McNally Pittsburg Mfg. Corp.
Woods Sons Co., T. B.

PILLOW BLOCKS, FLANGED MOUNTINGS

SKF Industries, Inc.

PILLOW BLOCKS, HANGERS

Bartlett, C. O., & Snow Co.
Bearings, Inc.
Bearing Service Co.
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Dodge Mfg. Corp.—"DODGE-TIMKEN"
Fafnir Bearing Co.
Fairmont Machinery Co.
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Jones Foundry & Machine Co.
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Stephens-Adamson Mfg. Co.
Transall, Inc.
Webster Mfg., Inc.
Wilmot Engineering Co.

PILLOW BLOCKS, ROLLER-BEARING
Silver Engineering Works, Inc.

PIPE, ALUMINUM
Aluminum Company of America—"ALCLAD"
Reynolds Metals Co.

PIPE, ASBESTOS-CEMENT
Johns-Manville Corp.—"TRANSITE"

PIPE, CAST IRON
American Brake Shoe Co.
Goyne Pump Co.
U. S. Pipe & Foundry Co.

PIPE, CAST IRON, WROUGHT IRON
Albert Pipe Supply Co.
Midland Pipe & Supply Co.
Wilmot Engineering Co.

PIPE, CEMENT-LINED
Albert Pipe Supply Co.
Goyne Steam Pump Co.
Jones & Laughlin Steel Corp.

PIPE, COPPER, RED BRASS
Revere Copper & Brass, Inc.

PIPE, CORRUGATED
Armco Drainage & Metal Products, Inc.

PIPE, FABRICATION
Dravo Corp.

PIPE, IRRIGATION, ALUMINUM
Aluminum Company of America

PIPE, PLASTIC
Albert Pipe Supply Co.
Carlon Products Corp.—"CARLON EF," "CARLON E"
Crane Co.
Failing Co., George E.
Franklin Plastic, Inc.—"DUR-X"
Gates Rubber Co.—"FLEX-FLO"
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Graybar Electric Co., Inc.
Guyan Machinery Co.
Hamilton Rubber Mfg. Corp.
Johnson Plastic Corp.
Magic Chemical Co.
Midland Pipe & Supply Co.
National Mine Service Co.
Plastex Co.—"PLASTEX MEASURE-MARKED"
Quaker Rubber Corp., Div. of H. K. Porter Company, Inc., of Pittsburgh
Republic Steel Corp. "REPUBLIC"
U. S. Rubber Co., Mechanical Goods Div.
U. S. Steel Supply Co.
Waljohn Plastics Co.
Yardley Plastics Co.—"CLEAR STREAM"
Youngstown Sheet & Tube Co.

PIPE, RUBBER
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Goodyear Tire & Rubber Co.
Hewitt-Robins, Inc.
Linatex Corp. of America
Magic Chemical Co.
Manhattan Rubber Div., Raybestos-Manhattan, Inc.
New York Belting & Packing Co.—"INDESTRUCTIBLE"
Quaker Rubber Corp., Div. of H. K. Porter Company, Inc., of Pittsburgh
U. S. Rubber Co., Mechanical Goods Div.

PIPE, RUBBER-LINED
Galigher Co.—"GALIGHER"
Manhattan Rubber Div., Raybestos-Manhattan, Inc.

PIPE, SLUDGE
Armco Drainage & Metal Products, Inc.

PIPE, SPIRAL-WELDED, STEEL, RUBBER-LINED
Naylor Pipe Co.

PIPE, STEEL
Acker Drill Co.
Albert Pipe Supply Co.—"SPEED-LAY"
Armco Drainage & Metal Products, Inc.
Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"CF&I"
Crucible Steel Co. of America
Graybar Electric Co., Inc.
Jones & Laughlin Steel Corp.
McNally Pittsburg Mfg. Corp.
Midland Pipe & Supply Co.
Republic Steel Corp.—"REPUBLIC"
Ryerson & Co., Inc., Joseph T.
Triangle Conduit & Cable Co.
U. S. Hoffman Machinery Corp.—"SMOOTH-FLO"
U. S. Pipe & Foundry Co.
U. S. Steel Supply Co., Div., United States Steel Corp.
Wheeling Steel Corp.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"CLAYMONT"
Youngstown Sheet & Tube Co.

PIPE, STEEL WELDED
Eimco Corp.

PIPE, WOOD
Michigan Pipe Co.
Sutphen, Peter O.

PIPE, WOOD-LINED STEEL
Michigan Pipe Co.

PIPE, WOOD-STAVE
Michigan Pipe Co.

PIPE, WROUGHT IRON
Acker Drill Co.
Byers, A. M., Co.

PIPE & FITTINGS, BRONZE
Goyne Pump Co.

PIPE COUPLINGS
Albert Pipe Supply Co.
Crane Co.
Dresser Mfg. Div., Dresser Industries
Grinnell Co.
Gustin-Bacon Mfg. Co.—"GRUVAJOINT," "GRUVAGRIP," "ROLAGRIP"
Jones & Laughlin Steel Corp.
Johns-Manville Corp.—"RING-TITE"
Midland Pipe & Supply Co.
Plastex Co.
Triangle Conduit & Cable Co.
Victaulic Co. of America—"VICTAULIC," "STANDARD," "LIGHTWEIGHT," "SNAP-JOINT," "ROUST-A-BOUT"
Walworth Co.
Youngstown Sheet & Tube Co.

PIPE COVERINGS
Philip Carey Mfg. Co.

PIPE FITTINGS
Albert Supply Co.
Dresser Mfg. Div., Dresser Industries, Inc.
Gustin-Bacon Mfg. Co.—"GRUVAGRIP"
Victaulic Co. of America—"FULL-FLOW"

PIPE FITTINGS, FLANGES, PLASTIC
Tube Turns Plastic, Inc.

PIPE FITTINGS, FLANGES, WELDING
Tube Turns Div., National Cylinder Gas Co.—"TUBE-TURN"

PIPE FITTINGS, PLASTIC
Franklin Plastics, Inc.—"DUR-X"

PIPE HOOKS
Newman Mfg. & Sales Co.—"NEWCO"

PIPE REPAIR CLAMPS, SLEEVES
Dresser Mfg. Div., Dresser Industries, Inc.

PIPE TOOLS
Beaver Pipe Tools, Inc.
Toledo Pipe Threading Machine Co.
Victaulic Co. of America

PISTON RINGS
Koppers Co.—"AMERICAN HAMMERED"

PLATE, ALLOY
Revere Copper & Brass, Inc.

PLATE, ALLOY & STEEL
American Manganese Steel Div., American Brake Shoe Co.
Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"CF&I"
Illinois Zinc Co.—"ERAYDO ALLOY"
Inland Steel Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Mahon Co., R. C.
Republic Steel Corp.—"REPUBLIC"
Ryerson & Son, Inc., Joseph T.
Sheffield Steel Div., Armco Steel Corp.
U. S. Steel Corp.
U. S. Steel Supply Co., Div. of United States Steel Corp.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"CLAYMONT"
Youngstown Sheet & Tube Co.

PLATE, RAIL BRACE & TIE
Gibraltar Equipment & Mfg. Co.

PLATE & SHEET, ALUMINUM
Aluminum Company of America

PLUGS & RECEPTACLES
Crouse-Hinds Co.—"ARKTITE"
Delta-Star Electric Div., H. K. Porter Company, Inc., of Pittsburgh

POLE-LINE MATERIALS
American Hoist & Derrick Co.—"LAUGHLIN"
Flood City Brass & Electric Co.
Graybar Electric Co., Inc.
Mosebach Electric & Supply Co.
Oliver Iron & Steel Corp.
Rome Cable Corp.

POLES, TREATED
Moss Tie Co., T. J.

POLES, PRESSURE-TREATED
American Lumber & Treating Co.

POLLUTION-CONTROL SYSTEMS
Denver Equipment Co.

PORTABLE LOADERS, BELT
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.

PORTABLE LOADERS, BELT, BUCKET, CHAIN
American Conveyor Co.
Baughman Mfg. Co.
Bonded Scale & Machine Co.—"BONDED"
Christian Engineers, J. D.
Herold Mfg. Co.
Irwin Foundry & Mine Car Co.
Kremser & Sons, Inc., Frank A.
Magnetic Engineering & Mfg. Co.
Marsh Engineering Co., E. F.
Pettibone Mulliken Corp.

PORTABLE PREPARATION PLANTS
Bonded Scale & Machine Co.
Daniels Co., Contractors, Inc.
Iowa Mfg. Co.
Holmes & Bros., Inc., Robert
Prins & Associates, K.
Thomas Engineering & Construction Co.
WEMCO Div., Western Machinery Co.—"WEMCO MOBIL-MILL"

PORTABLE TOOLS, AIR
Cleco Div., Reed Roller Bit Co.—"CLECO"
Worthington Corp.

PORTABLE TOOLS, AIR, ELECTRIC
Chicago Pneumatic Tool Co.
Cincinnati Electric Tool Co.
Graybar Electric Co., Inc.
Ingersoll-Rand Co.
Mall Tool Co.
Martindale Electric Co.
Penn Machine Co.
Snap-On Tools Corp.—"SNAP-ON"
Syntron Co.
Thor Power Tool Co.

PORTABLE TOOLS, ELECTRIC
Black & Decker Mfg. Co.

POWDER BAGS
American Brattice Cloth Corp.
American Cyanamid Co., Explosives Dept.

POWDER BAGS, BOXES
American Brattice Cloth Corp.
Bemis Bros. Bag Co.
King Powder Co., Inc.
Mine Safety Appliances Co.

POWDER BOXES, SAFETY WOOD
Hammond Co., J. V.

POWDER-POWERED TOOLS
Mine Safety Appliances Co.
Olin Mathieson Chemical Corp.—"RAMSET"
Remington Arms Co., Inc.

POWDER STORAGE, FIELD UNITS
Dravo Corp.

POWER UNITS, HYDRAULIC
Schroeder Brothers

PREPARATION BUILDERS
Daniels Co., Contractors, Inc.
Davis Co., Nelson L.
Fairmont Machinery Co.
Heyl & Patterson, Inc.
Kanawha Mfg. Co.
McNally Pittsburg Mfg. Corp.
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Wilmot Engineering Co.

PRESSES, HYDRAULIC
Baldwin-Lima-Hamilton Corp.
Blackhawk Mfg. Co.
Mahon Co., R. C.

PULLERS, FUSE
Trico Fuse Mfg. Co.

PULLERS, GEAR & WHEEL
Armstrong-Bray & Co.
Bearings, Inc.
Blackhawk Mfg. Co.
Complete Reading Electric Co., Inc.
Joffroy Mfg. Co.
Martindale Electric Co.
Nolan Co.
Snap-On Tools Corp.—"SNAP-ON"

PULLERS, GEAR & WHEEL, HYDRAULIC
Armstrong-Bray & Co.

PULLERS, HYDRAULIC PORTABLE
Templeton, Kenly & Co.—"JENNY," "REMOTROL"

PULLEYS, GAGE OR SLAT
Silver Engineering Works, Inc.

PULLEYS, CAST IRON
Continental Gin Co., Industrial Div.
Jones Foundry Co., W. A.
Woods Sons Co., T. B.
Webster Mfg., Inc.

PULLEYS, CONVEYOR
American Pulley Co.

PULLEYS, IDLER, BALL BEARING
Fafnir Bearing Co.

PULLEYS, MAGNETIC
Dings Magnetic Separator Co.

PULLEYS, PAPER
Browning Mfg. Co.

PULLEYS, SEMI-STEEL
McLanahan & Stone Corp.

PULLEYS, STEEL
Brad-Foote Gear Works
Continental Gin Co., Industrial Div.
Dayton Rubber Co.—"DAYTON"
McNally Pittsburg Mfg. Corp.
Penn Machine Co.
Sprout, Waldron & Co., Inc.—"BELT-SAVER"
Woods Sons Co., T. B.

PULLEYS, STEEL & WOOD
American Pulley Co.—"HITORQUE"
Bonded Scale & Machine Co.—"BONDED"
Christian Engineers, J. D.
Dodge Mfg. Corp.
Gates Rubber Co.
Holmes & Bros., Inc., Robert
Link-Belt Co.—"LINK-BELT"

PULVERIZERS
Combustion Engineering, Inc., Raymond Div.

PULVERIZERS, LABORATORY
Combustion Engineering, Inc., Raymond Div.

PUMPING STATIONS
Acker Drill Co.

PUMP-PRIMING EQUIPMENT
Barrett, Haentjens & Co.—"HAZLETON"
Goyne Steam Pump Co.
Marlow Pumps

PUMPS, ACID-RESISTING
Duriron Co., Inc.

PUMPS, CENTRIFUGAL
Allis-Chalmers Mfg. Co.
Barnes Mfg. Co.
Duriron Co., Inc.
Gorman Rupp Co.
Goyne Pump Co.
Labour Co., Inc.
McNally Pittsburg Mfg. Corp.
Morris Machine Works
Wilfley & Sons, A. R.

PUMPS, CENTRIFUGAL & TURBINE
Allis-Chalmers Mfg. Co.
American Brake Shoe Co.
American-Marsh Pumps, Inc.
American Well Works
Aurora Pump Div., The New York Air Brake Co.
Barrett, Haentjens & Co.—"HAZLETON"
Chain Belt Co.—"REX"
Chicago Pneumatic Tool Co.
Davidson Co., M. T.
Dean Brothers Pumps, Inc.
De Laval Steam Turbine Co.
Deming Co.
Dorr-Oliver Incorporated—"OLIVITE"
Ensign Electric & Mfg. Co.
Failing Co., George E.
Fairbanks, Morse & Co.
Flood City Brass & Electric Co.
Gardner-Denver Co.—"GARDNER-DENVER"
Goulds Pumps, Inc.
Homelite Corp.—"HOMELITE"
Ingersoll-Rand Co.
Lancaster Pump & Mfg. Co., Inc.
Layne & Bowler, Inc.
Marlow Pumps
National Mine Service Co.
New York Air Brake Co., The—"AURORA"
Pennsylvania Drilling Co.
Pennsylvania Pump & Compressor Co.
Pettibone Mulliken Corp.
Rice Pump & Machine Co.
Smith Co., A. O.
Warren Steam Pump Co.
Webb Corp.
WEMCO Div., Western Machinery Co.—"WEMCO"
Worthington Corp.

PUMPS, DIAPHRAGM
Barrett, Haentjens & Co.—"HAZLETON"
B-I-F Industries, Inc., Proportioneers Div.—"ADJUST-O-FEEDER"
Barnes Mfg. Co.—"MUD-N-SLUDGE"
Chain Belt Co.—"REX"
Construction Machinery Co.
Denver Equipment Co.
Dorr-Oliver Incorporated—"ODS"
Gorman Rupp Co.
Herold Mfg. Co.
Hewitt-Robins, Inc.—"MONARCH," "AJAX"
Jaeger Machine Co.
Marlow Pumps
Rice Pump & Machine Co.
Warren Steam Pump Co.
Webb Corp.
WEMCO Div., Western Machinery Co.—"WEMCO"
Worthington Corp.

PUMPS, DRUM
Gray & Co., Inc.

PUMPS, JET
Jacuzzi Bros., Inc.
United Conveyor Corp.

PUMPS, METERING
WEMCO Div., Western Machinery Co.—"WEMCO"

PUMPS, PISTON & PLUNGER
Aldrich Pump Co.
American-Marsh Pumps, Inc.
B-I-F Industries, Inc., Proportioneers Div.
Dean Brothers Pumps, Inc.
Deming Co.
Dorr-Oliver, Incorporated
Failing Co., George E.
Fairbanks, Morse & Co.
Fairmont Machinery Co.
Flood City Brass & Electric Co.
Gardner-Denver Co.—"GARDNER-DENVER"
Goulds Pumps, Inc.
Lancaster Pump & Mfg. Co., Inc.
Lincoln Engineering Co.
Longyear Co., E. J.
Marlow Pumps
National Mine Service Co.
New York Air Brake Co., The—"KINNEY"
Sanford-Day Iron Works, Inc.—"BROWNIE"
Vickers, Inc.
Warren Steam Pump Co.
Worthington Corp.

PUMPS, SELF-PRIMING CENTRIFUGAL
Construction Machinery Co.
Gorman Rupp Co.
Jaeger Machine Co.
Labour Co., Inc.

PUMPS, SOLIDS-HANDLING

Allen-Sherman Hoff Pump Co.—"HYDRO-SEAL," "CENTRISEAL"
Allis-Chalmers Mfg. Co.
American Brake Shoe Co.
American-Marsh Pumps, Inc.
Aurora Pump Div., New York Air Brake Co., The
Barrett, Haentjens & Co.—"HAZLETON"
Chain Belt Co.—"REX"
Chicago Pneumatic Tool Co.
Denver Equipment Co.
Fairbanks-Morse & Co.
Galigher Co.—"VACSEAL"
Gardner-Denver Co.—"GARDNER-DENVER"
Gorman Rupp Co.
Goulds Pumps, Inc.
Goyne Pump Co.
Gray & Co.—"POWERFLO"
Herold Mfg. Co.
Lancaster Pump & Mfg. Co.
Linatex Corp. of America
Lincoln Engineering Co.
Marcy Mill Div., Mine & Smelter Supply Co.
Morris Machine Works
Nagle Pumps, Inc.
New York Air Brake Co., The—"KINNEY"
Robbins & Myers, Inc.—"MOYNO"
Warren Steam Pump Co.
WEMCO Div., Western Machinery Co.—"WEMCO TORQUE-FLOW"
Wilfley & Sons, Inc., A. R.
Worthington Corp.

PUMPS, SUMP

Galigher Co.—"GALIGHER"
Nagle Pumps, Inc.
Schramm, Inc.

PUMPS, VERTICAL, CENTRIFUGAL

WEMCO Div., Western Machinery Co.—"WEMCO"

PUSHBUTTONS

Allen-Bradley Co.
Allis-Chalmers Mfg. Co.
Arrow Hart & Hegeman Electric Co.
Christian Engineers, J. D.
Cutler-Hammer, Inc.
General Electric Co., Apparatus Sales Div.
Graybar Electric Co., Inc.
Mosebach Electric Supply Co.
Square D Co.

PYROMETERS

West Instrument Corp.

RADIO SYSTEMS

Federal Telephone & Radio Corp.
Femco, Inc.—"TROLLEYPHONE"
General Electric Co., Communication Equipment
Graybar Electric Co., Inc.
Mine Safety Appliances Co.—"MINE-PHONE"
Motorola Communications & Electronics, Inc.
Radio Corp. of America, Engineering Products Div.—"CARFONE"

RAIL

Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"CF&I"
Foster Co., L. B.
Gibraltar Equipment & Mfg. Co.
Inland Steel Co.
Morse Bros. Machinery Co.
United States Steel Corp.
West Virginia Steel & Mfg. Co.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"CF&I"

RAIL CAR STOP, ELECTRIC

Cheatham Electric Switching Device Co.

RAIL BENDERS

Card, C. S., Iron Works Co.
Duquesne Mine Supply Co.
Gibraltar Equipment & Mfg. Co.—"GIMCO TRU-BLU"
National Mine Service Co.
Salem Tool Co.—"SALEM"
Utility Mine Equipment Co.—"RUMECO"
Watt Car & Wheel Co.
West Virginia Steel & Mfg. Co.

RAIL-BOND TERMINALS

American Mine Door Co.

RAIL BONDS

American Steel & Wire Div., U. S. Steel Corp.—"TIGERWELD"
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
Delta-Star Electric Div., H. K. Porter Co., Inc., of Pittsburgh
Electrical Distributors Co.
Ensign Electric & Mfg. Co.
Erico Products, Inc.—"CADWELD"
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Brass Co.
Penn Machine Co.—"EVERLAST SUPER-WELD"

RAIL BRACES

American Brake Shoe Co.
Bethlehem Steel Co.
Card, C. S., Iron Works Co.
Gibraltar Equipment & Mfg. Co.
Nolan Co.
Pettibone Milliken Corp.—"TOPNOTCHER"
West Virginia Steel & Mfg. Co.

RAIL CLAMPS

Bethlehem Steel Co.
Heyl & Patterson, Inc.
Mosebach Electric & Supply Co.
West Virginia Steel & Mfg. Co.

RAIL DOLLIES

Templeton, Kenly & Co.

RAIL DRILLS

Chicago Pneumatic Tool Co.
Gibraltar Equipment & Mfg. Co.
Nordberg Mfg. Co.

RAIL FROGS

American Brake Shoe Co.
Bethlehem Steel Co.
Card, C. S., Iron Works Co.
Morse Bros. Machinery Co.
Pettibone Milliken Corp.
Taylor-Wharton Iron & Steel Co.
West Virginia Steel & Mfg. Co.

RAIL PUNCHES

Duquesne Mine Supply Co.
Gibraltar Equipment & Mfg. Co.
Mine Safety Appliances Co.
National Mine Service Co.
Utility Mine Equipment Co.—"UMECO"

RAIL SIGNAL SYSTEMS

American Mine Door Co.
Cheatham Electric Switching Device Co.
Nachod & U. S. Signal Co.

RAIL SPIKES

Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"CF&I"
Gibraltar Equipment & Mfg. Co.
Inland Steel Co.
Jones & Laughlin Steel Corp.
Morse Bros. Machinery Co.
National Mine Service Co.
Sheffield Steel Div., Armco Steel Corp.
West Virginia Steel & Mfg. Co.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.
Youngstown Sheet & Tube Co.

RAIL SPLICE BARS, FISHPLATES

Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"CF&I"
Gibraltar Equipment & Mfg. Co.
Inland Steel Co.
Morse Bros. Machinery Co.
West Virginia Steel & Mfg. Co.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.

RAIL SPRING-SWITCH SNUBBERS

Cheatham Electric Switching Device Co.

RAIL SWITCH-POSITION INDICATORS

Cheatham Electric Switching Device Co.

RAIL SWITCHTHROWERS

American Brake Shoe Co.

RAIL SWITCHTHROWERS, AUTOMATIC

American Mine Door Co.—"ELECTRI-THROW"
Cheatham Electric Switching Device Co.
Pettibone Milliken Corp.
West Virginia Steel & Mfg. Co.

RAIL SWITCHTHROWERS, ELECTRIC, CAB-OPERATED

Cheatham Electric Switching Device Co.

RAIL TIE PLATES

American Brake Shoe Co.
Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"CF&I"
Gibraltar Equipment & Mfg. Co.
Inland Steel Co.
Jones & Laughlin Steel Corp.
Morse Bros. Machinery Co.
United States Steel Corp.
West Virginia Steel & Mfg. Co.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.

RAIL TIES, PRESSURE-TREATED

American Lumber & Treating Co.

RAIL TIES, STEEL

Bethlehem Steel Co.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"CF&I"
National Mine Service Co.
West Virginia Steel & Mfg. Co.

RAIL TIES, TREATED

Republic Creosoting Co.

RAIL TURNOUTS, SWITCHES, STANDS

American Brake Shoe Co.
Bethlehem Steel Co.
Card, C. S., Iron Works Co.
Morse Bros. Machinery Co.
Pettibone Milliken Corp.
West Virginia Steel & Mfg. Co.

RAIL WELDING

Metal & Thermit Corp.

RAIL & TRACK CONTACTORS

Nachod & U. S. Signal Co.

RAILS, TRANSITION

Miners Hardware Supply

RECTIFIERS, MERCURY-ARC

Allis-Chalmers Mfg. Co.
Dings Magnetic Separator Co.
General Electric Co., Apparatus Sales Div.
Hackbridge & Hewittic Electric Co., Ltd.
National Mine Service Co.
Westinghouse Electric Corp.

RECTIFIERS, GERMANIUM, SELENIUM, SILICON

Dings Magnetic Separator Co.
Federal Telephone & Radio Corp.
General Electric Co., Apparatus Sales Div.
Lewis Industries, Ltd.

Rapid Electric Co.
U. S. Hoffman Machinery Corp.
Westinghouse Electric Corp.

RECTIFIERS, SELENIUM

Kersey Mfg. Co.
Mine Safety Appliances Co.
Syntron Co.

REDUCERS, SHAFT-MOUNTED

Falk Corp.

REDUCTION GEARS

Twin Disc Clutch Co.

REFRACTORIES

Mexico Refractories Co.—"MEX-R-CO," "MONO-FIBRIK," "MEX-BOND," "HELSPOT"

REGULATORS, DRAFT

Bristol Co.—"BRISTOLS"
Hayes Corp.
Minneapolis-Honeywell Regulator Co., Industrial Div.

REGULATORS, DRAFT, PRESSURE

Cash Co., A. W.—"CASH STANDARD"

REGULATORS, PRESSURE

Victor Equipment Co.

REGULATORS, TEMPERATURE

Bristol Co.—"BRISTOLS"
Cutler-Hammer, Inc.
Fischer & Porter Co.
Hayes Corp.
Minneapolis-Honeywell Regulator Co., Industrial Div.

REGULATORS, VOLTAGE

Allis-Chalmers Mfg. Co.
Cutler-Hammer, Inc.
Electric Machinery Mfg. Co.
Federal Telephone & Radio Corp.
Fischer Scientific Co.
Graybar Electric Co., Inc.

RELAYS, ELECTRICAL

Allen-Bradley Co.
Allis-Chalmers Mfg. Co.
Arrow Hart & Hegeman Electric Co.
Clark Controller Co.
Cheatham Electric Switching Device Co.
Cutler-Hammer, Inc.
Elastic Stop Nut Corp. of America, A.G.A. Div.
Federal Telephone & Radio Corp.
Graybar Electric Co., Inc.
Heinemann Electric Co.
Jeffrey Mfg. Co.
Nachod & U. S. Signal Co.
Square D Co.

RELAYS, ELECTRICAL, MERCURY

Durakool, Inc.

REPAIR SERVICE, MINE EQUIPMENT

Flood City Brass & Electric Co.
Gibraltar Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Industrial Machine & Electric Co.
Holmes & Bros., Inc., Robert
Joy Mfg. Co.
Lee-Norse Co.
National Electric Coil Co.
National Mine Service Co.
Webb Corp.

RERAILERS

American Mine Door Co.
Duquesne Mine Supply Co.
Miners Hardware Supply
Nolan Co.

RESISTORS

Allen-Bradley Co.
Carboloy Dept., General Electric Co.
Clark Controller Co.
Cutler-Hammer, Inc.
Electric Controller & Mfg. Co.
Ensign & Electric Mfg. Co.
General Electric Co., Apparatus Sales Div.
Graybar Electric Co., Inc.
Guyan Machinery Co.—"GUYAN"
Ironton Engine Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Carbon Co.
Penn Machine Co.
Post-Glover Electric Co.

RESPIRATORS

American Optical Co.
Bullard Co., E. D.
Chicago Eye Shield Co.
Fischer Scientific Co.
General Scientific Equipment Co.
Martindale Electric Co.
Mine Safety Appliances Co.—"DUSTFO," "COMFO"
Pulmosan Safety Equipment Corp.
Willson Products, Inc.

RETAINERS, BEARING

Bearings, Inc.

RETAINERS, GREASE & OIL

Bearings, Inc.

RETARDERS, MINE-CAR

Nolan Co.

RHEOSTATS

Allen-Bradley Co.
Clark Controller Co.
Cutler-Hammer, Inc.
Fischer Scientific Co.
General Electric Co., Apparatus Sales Div.
Westinghouse Electric Corp.

RINGS, COLLECTOR, COMMUTATOR

West Virginia Armature Co.

RINGS, PISTON

Flocker & Co., John
Holmes & Bros., Inc., Robert

RIPPERS, CABLE

Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc.

RIPPERS, HYDRAULIC

Tractomotive Corp.

RIVER-LOADING PLANTS

Bartlett, C. O., & Snow Co.
Holmes & Bros., Inc., Robert
Heyl & Patterson, Inc.
Kanawha Mfg. Co.
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Webb Corp.

ROCK-DUST DISTRIBUTORS

Acme Machinery Co.
American Mine Door Co.—"DUST-MASTER," "LITTLE CHIEF," "MIGHTY MIDGET"
Fletcher & Co., J. H.
Imperial-Cantrell Mfg. Co.
Mine Safety Appliances Co.—"BANTAM," "FACEDUSTER"
Morse Bros. Machinery Co.

RODS, LEVEL

Brunson Instrument Co.

ROLLERS, ROAD

Galion Iron Works & Mfg. Co.

ROLLERS, SLOPE

Vulcan Iron Works

ROOF BARS, ALUMINUM

Herold Mfg. Co.

ROOF-BOLT HOLE GAGES

Ohio Brass Co.

ROOF-BOLT PULLERS, HYDRAULIC

Templeton, Kenly & Co.

ROOF-BOLT TENSION INDICATORS

American Mine Supply Co.
Palnut Co.

ROOF BOLTS

Sheffield Steel Div., Armco Steel Corp.

ROOF BOLTS, EXPANSION-PLUG

Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"CF&I"
Elreco Corp.
National Mine Service Co.
Ohio Brass Co.
Oliver Iron & Steel Corp.
Palnut Co.
Pattin Mfg. Co.—"PATTIN"
Pittsburgh Screw & Bolt Corp.
Republic Steel Corp.—"REPUBLIC"
West Virginia Steel & Mfg. Co.
Youngstown Sheet & Tube Co.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.

ROOF BOLTS, SPLIT ROD & WEDGE

Bethlehem Steel Co.
Colorado Fuel & Iron Corp.
National Mine Service Co.
Oliver Iron & Steel Corp.
Palnut Co.
Pattin Mfg. Co.—"PATTIN"
Republic Steel Corp.—"REPUBLIC"
West Virginia Steel & Mfg. Co.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.
Youngstown Sheet & Tube Co.

ROOF RESURFACERS

Stonhard Co.

ROOF SUPPORTS, ALUMINUM

Templeton, Kenly & Co.

ROOF SUPPORTS, YIELDING ARCH

Herold Mfg. Co.

ROOFING

Carey Mfg. Co., Philip—"ASPHALT," "WINDMASTER," "SNO-CREST"

ROOFING, FLASHING, COPPER

Revere Copper & Brass, Inc.

ROOFING, SIDING, ALUMINUM

Aluminum Company of America
Kanawha Mfg. Co.
Mahon Co., R. D.
Revere Copper & Brass, Inc.
Reynolds Metal Co.
Steel Built Construction Co.

ROOFING, SIDING, ASBESTOS

Carey Mfg. Co., Philip—"FIRE-CHEX," "CERAMO," "CAREYSTONE"
Johns-Manville—"FLEXSTONE," "TRANSITE"
Kanawha Mfg. Co.
Keasbey & Mattison Co.—"CENTURY"
Ruberoid Co.
Steel Built Construction Co.

ROOFING, SIDING, GALVANIZED

Inland Steel Co.
Kanawha Mfg. Co.
Mahon Co., R. C.
Republic Steel Corp.—"REPUBLIC"
Ryerson & Son, Inc., Joseph T.

Steel Built Construction Co.
United States Steel Corp.

ROOFING, SIDING, ZINC

Illinois Zinc Co.

SAFETY BELTS, HOOKS

Bullard Co., E. D.
Failing Co., George E.
General Scientific Equipment Co.
Mine Safety Appliances Co.

SAFETY BLOCKS, STOPS & CAR HOLDERS

Nolan Co.

SAFETY DISPLAYS, SIGNS

Bullard Co., E. D.
Elliott Service Co., Inc., Coal Mine Poster Div.
General Scientific Equipment Co.
Mine Safety Appliances Co.
Pulmosan Safety Equipment Co.

SAFETY FOOTGEAR

Bone Dry Shoe Mfg. Co.
Lehigh Safety Shoe Co., Inc.
Mine Safety Appliances Co.

SAFETY FOOTGEAR, RUBBER

Goodall Rubber Co.

SAFETY HEADGEAR

American Optical Co.
Bullard Co., E. D.
Failing Co., George E.
General Scientific Equipment Co.
Goodall Rubber Co.
Mine Safety Appliances Co.—"SKULLGARDS"
National Mine Safety Co.
Pulmosan Safety Equipment Co.
United States Safety Service Co.
Willson Products, Inc.—"SUPERTOUGH"

SAFETY HOOKS

American Hoist & Derrick Co.—"LAUGHLIN"
Newman Mfg. & Sales Co.—"NEWCO"

SALT

Diamond Crystal Salt Co.
International Salt Co.—STERLING "AUGER ACTION" ROCK SALT
Morton Salt Co.
United States Safety Service Co.

SAMPLERS, COAL

American Pulverizer Co.
Commercial Testing & Engrg. Co.
Fairmont Machinery Co.
Galigher Co.—"GEARY-JENNINGS"
Gruendler Crusher & Pulverizer Co.
Hoffman Bros. Drilling Co.
Holmes & Bros., Inc., Robert
McNally Pittsburg Mfg. Corp.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Sturtevant Mill Co.

SAMPLERS, COAL, AUTOMATIC

American Pulverizer Co.
Commercial Testing & Engrg. Co.
Denver Equipment Co.
Fairmont Machinery Co.
Fischer Scientific Co.
Galigher Co.—"GEARY-JENNINGS"
Hardinge Co., Inc.
Heyl & Patterson, Inc.—"THORSTEN"
McNally Pittsburg Mfg. Corp.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Sturtevant Mill Co.

SAND DRIERS

Denver Equipment Co.
Eimco Corp.
Iowa Mfg. Co.
Indiana Foundry Co.—"SUTTON"
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Webb Corp.

SAW BLADES, CIRCULAR

Simonds Saw & Steel Co.—"SI-CLONE"

SAWS, BAND, CIRCULAR, HACK

Disston & Sons, Inc., Henry

SAWS, PORTABLE ELECTRIC

Black & Decker Mfg. Co.

SAWS, POWER

Fletcher & Co., J. H.
Graybar Electric Co., Inc.
Homelite Corp.—"HOMELITE"
Joy Mfg. Co.
Penn Machine Co.
Syntron Co.
Wright Power Saw & Tool Co., Sub. of Thomas Industries, Inc.

SCALE WEIGHT RECORDERS

Baldwin-Lima-Hamilton Corp.
Buffalo Scale Co., Inc.
Failing Co., George E.
Fairbanks, Morse & Co.
Howe Scale Co., Inc.
Screen Equipment Co.
Streeter-Amet Co.
Thurman Machine Co.
Toledo Scale Co.
Webb Corp.

SCALES, MINE CAR, TRUCK

Baldwin-Lima-Hamilton Corp.
Bonded Scale & Machine Co.—"BONDED"
Buffalo Scale Co., Inc.
Fairbanks, Morse & Co.
Howe Scale Co.
Screen Equipment Co.
Streeter-Amet Co.
Thurman Machine Co.
Toledo Scale Co.
Webb Corp.
Winslow Government Standard Scale Works, Inc.

SCALES, R. R.

Baldwin-Lima-Hamilton Corp.
Buffalo Scale Co., Inc.
Fairbanks-Morse & Co.
Howe Scale Co., Inc.
Morse Bros. Machinery Co.
Screen Equipment Co.
Streeter-Amet Co.
Webb Corp.
Winslow Government Standard Scale Works, Inc.

SCRAPERS, CRESCENT DRAG

Sauerman Bros., Inc.

SCRAPERS, SELF-POWERED

Austin-Western Co., Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
International Harvester Co.
LeTourneau-Westinghouse Co.—"TOURNAPULLS"
Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc.—"TERRA COBRA"

SCRAPERS, TRACTOR-POWERED

American Tractor Corp.—"TERRATRAC"
Caterpillar Tractor Co.
International Harvester Co.
LeTourneau-Westinghouse Co.
Oliver Corp.
Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc.

SCRAPERS, UNDERGROUND

Eimco Corp.
Joy Mfg. Co.

SCREEN BARS

American Brake Shoe Co.
Bixby-Zimmer Engineering Co.
Bonded Scale & Machine Co.
Card, C. S., Iron Works Co.
Chain Belt Co.—"REX"
Holmes & Bros., Inc., Robert
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Kensington Steel Co.
Link-Belt Co.—"LINK-BELT"
McNally Pittsburg Mfg. Corp.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Phillips Div., Salem-Brosius, Inc.
Savage Co., W. J.
Taylor-Wharton Iron & Steel Co.
Wedge Wire Corp.

SCREEN CLOTH

Bixby-Zimmer Engineering Co.
Bonded Scale & Machine Co.
Buffalo Wire Works Co., Inc.
Cambridge Wire Cloth Co.
Cleveland Wire Cloth & Mfg. Co.
Colorado Fuel & Iron Corp.—"CAL-WIC"
Flocker & Co., John
Hewitt-Robins, Inc.
Hoyt Wire Cloth Co.—"SUPERTOUGH," "STAINLESS," "ABRASO"
Iowa Mfg. Co.
Kanawha Mfg. Co.
Lecco Machinery & Engineering Co.
Link-Belt Co.—"LINK-BELT"
Ludlow Saylor Wire Cloth Co.
Pioneer Engineer Works, Inc.
Productive Equipment Corp.—"MUSIC WIRE," "ROD TYPE"
Savage Co., W. J.
Simplicity Engineering Co.
Taylor-Wharton Iron & Steel Co.
Tyler Co., W. S.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"GOLD-STRAND"

SCREEN HEATERS

Deister Concentrator Co.
Deister Machine Co.
Flocker & Co., John
Hannon & Sons, F. R.—"HANCO"
Link-Belt Co.—"LINK-BELT"
Tyler Co., W. S.
Universal Vibrating Screen Co.—"UNILEC"

SCREEN PLATE

Hendrick Mfg. Co.

SCREEN PLATE, SHEET, PERFORATED

American Manganese Steel Div., American Brake Shoe Co.
Card, C. S., Iron Works Co.
Chicago Perforating Co.
Diamond Mfg. Co.
Flocker & Co., John
Harrington & King Perforating Co.
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Kanawha Mfg. Co.
Laubenstein Mfg. Co.
Lecco Machine & Engineering Co.
Link Belt Co.—"LINK-BELT"
McNally Pittsburg Mfg. Corp.
Phillips Div., Salem Brosius, Inc.
Remaly Mfg. Co.
Savage Co., W. J.
Standard Stamping & Perforating Co.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"WISSCO"

SCREEN WIRE

Bixby-Zimmer Engineering Co.
Cambridge Wire Cloth Co.
Cleveland Wire Cloth & Mfg. Co.
Colorado Fuel & Iron Corp.—"CAL-WIC"

Flocker & Co., John
Hoyt Wire Cloth Co.—"SUPERTOUGH," "STAINLESS," "ABRASO"
Lecco Machine & Engineering Co.
Michigan Wire Cloth Co.
Savage Co., W. J.
Taylor-Wharton Iron & Steel Co.
Tyler Co., W. S.
Wedge Wire Corp.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"CF&I," "WICKWIRE"

SCREENS

Cleveland Wire Cloth & Mfg. Co.
Hendrick Mfg. Co.
Newark Wire Cloth Co.
Remaly Mfg. Corp.

SCREENS, CENTRIFUGAL

Bird Machine Co.
Centrifugal & Mech. Industries, Inc.—"C-M-I"
Kanawha Mfg. Co.
Laubenstein Mfg. Co.
Nordberg Mfg. Co.

SCREENS, DEWATERING

Allis-Chalmers Mfg. Co.
Bartlett, C. O., & Snow Co.
Bonded Scale & Machine Co.—"BONDED"
Denver Equipment Co.
Fairmont Machinery Co.
Flocker & Co., John
Hewitt-Robins, Inc.—"ELIPTEX DEWATERIZER"
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engineering Corp.
Laubenstein Mfg. Co.
Lecco Machine & Engineering Co.—"LECCO-VIB"
Link-Belt Co.—"LINK-BELT"
McNally Pittsburg Mfg. Corp.
Nolan Co.—"RADIAL"
Nordberg Mfg. Co.
Phillips Div., Salem-Brosius, Inc.
Productive Equipment Corp.—"SELECTRO," "GYROSET"
Tyler Co., W. S.
Screen Equipment Co., Inc.
Simplicity Engineering Co.
Standard Stamping & Perforating Co.
Syntron Co.
Webb Corp.

SCREENS, REVOLVING

Allis-Chalmers Mfg. Co.
Bartlett, C. O., & Snow Co.
Chain Belt Co.—"REX"
Denver Equipment Co.
Flocker & Co., John
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kinney Engineers, Inc., S. P.
Laubenstein Mfg. Co.
Link-Belt Co.—"LINK-BELT"
McLanahan & Stone Corp.
Nordberg Mfg. Co.
Phillips Div., Salem-Brosius, Inc.
Savage Co., W. J.
Standard Stamping & Perforating Co.
Straub Mfg. Co., Inc.
Stephens-Adamson Mfg. Co.
Traylor Engineering & Mfg. Co.
Tyler Co., W. S.
Universal Engineering Co.
Webb Corp.

SCREENS, SCALPING

Simplicity Engineering Co.

SCREENS, SHAKER

Bonded Scale & Machine Co.—"BONDED"
Denver Equipment Co.
Fairmont Machinery Co.
Flocker & Co., John
Fischer Scientific Co.
Holmes & Bros., Inc., Robert
Industrial Engrg. & Construction Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Kinney Engineers, Inc., S. P.
Laubenstein Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Lippmann Engineering Works
McLanahan Stone Corp.
McNally Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Prins & Associates, K.
Ridge Equipment Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Savage Co., W. J.
Standard Stamping & Perforating Co.
Tyler Co., W. S.
Webb Corp.

SCREENS, VIBRATING

Allis-Chalmers Mfg. Co.
Bonded Scale & Machine Co.—"BONDED"
Buffalo Wire Works Co., Inc.
Deister Concentrator Co.—"LEAHY HEAVY DUTY NO BLIND"
Deister Machine Co.
Denver Equipment Co.
Fairmont Machinery Co.
Flocker & Co., John
Hewitt-Robins, Inc.—"ELIPTEX," "GYREX," "HYDREX"
Holmes & Bros., Inc., Robert
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Kinney Engineers, Inc., S. P.
Laubenstein Mfg. Co.
Lecco Machine & Engineering Co.—"LECCO-VIB"
Link-Belt Co.—"LINK-BELT"
Lippmann Engineering Works
McLanahan & Stone Corp.
McNally Pittsburg Mfg. Co.
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Pioneer Engineering Works
Productive Equipment Corp.—"SELECTRO," "GYROSET"
Ridge Equipment Co.
Screen Equipment Co.
Simplicity Engineering Co.
Smith Engineering Works
Standard Stamping & Perforating Co.
Stephens-Adamson Mfg. Co.
Straub Mfg. Co., Inc.
Sturtevant Mill Co.
Syntron Co.
Tyler Co., W. S.—"ELIPTEX," "GYREX," "HYDREX"
Universal Engineering Co.
Universal Vibrating Screen Co.—"UNIVERSAL," "UNIFLEX," "UNIVIBE"
Webb Corp.
Williams Patent Crusher & Pulverizer Co.

SCREENS, VIBRATING, TESTING

Gilson Screen Co.

SCREENS, WEDGE-WIRE

Wedge Wire Corp.—"KLEEN SLOT"

SCREENS, WELDED-ROD

Bixby-Zimmer Engineering Co.

SEALS, GREASE & OIL

Failing Co., George E.
Garlock Packing Co.
Johns-Manville—"CLIPPER"
West Virginia Armature Co.

SELF-RESCUERS

Mine Safety Appliances Co.

SEPARATORS, AIR

Sturtevant Mill Co.
U. S. Hoffman Machinery Corp.

SHACKLES, WIRE ROPE

Upson-Walton Co.

SHAFTING, STEEL

Bartlett, C. O., & Snow Co.
Christian Engineers, J. D.
Guyan Machinery Co.
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
McNally Pittsburg Mfg. Corp.
Republic Steel Corp.—"REPUBLIC"
Ryerson & Son, Inc., Joseph T.
Silver Engineering Works, Inc.
Tracy Co., Bertrand P.
U. S. Steel Supply Co., Div. of United States Steel Corp.
Webb Corp.
West Virginia Armature Co.

SHAPES, STRUCTURAL, ALUMINUM

Aluminum Company of America
Reynolds Metals Co.

SHEAVES

Dayton Rubber Co.—"DAYTON EL"

SHEAVES, HOISTING

American Manganese Steel Div., American Brake Shoe Co.
American Hoist & Derrick Co.—"AMERICAN CROSBY"
Bartlett, C. O., & Snow Co.
Card, C. S., Iron Works Co.
Connellsville Mfg. & Mine Supply Co.
Holmes & Bros., Inc., Robert
Joy Mfg. Co.
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Sauerman Bros., Inc.
Taylor-Wharton Iron & Steel Co.
Tool Steel Gear & Pinion Co.
Upson-Walton Co.
Vulcan Iron Works—"ALLCASTEEL"
Wellman Engineering Co.
Wilmot Engineering Co.

SHEAVES, TRACK & ROLLER

American Brake Shoe Co.
Card, C. S., Iron Works
Connellsville Mfg. & Mine Supply Co.
Irwin Foundry & Mine Car Co.
Holmes & Bros., Inc., Robert
McNally Pittsburg Mfg. Corp.
Tracy Co., Bertrand P.
Webb Corp.

SHEAVES, V-BELT

American Pulley Co.—"WEDGE-TITE"
Boston Woven Hose & Rubber Co.
Browning Mfg. Co.
Jones Foundry Co., W. A.
Woods Sons Co., T. B.

SHELVING, RACKS, ETC.

Delta-Star Electric Div., H. K. Porter, Inc., of Pittsburgh — "UNI-TRAY CABLE-WAY"
Frick-Gallagher Mfg. Co.—"KLIP-BILT"
National Mine Service Co.
Remington Rand, Div. Sperry Rand Corp.
Republic Steel Corp.—"REPUBLIC"

SHIM STOCK, SOLID, LAMINATED BRASS

Federal-Mogul Service

SHOCK ABSORBERS, MACHINE & MOTOR MOUNTS

Goodrich Co., B. F., Industrial Products Div.
New York Belting & Packing Co.—"GILMER"

SHOTFIRERS

Mine Safety Appliances Co.
National Mine Service Co.
Olin Mathieson Chemical Corp.

SHOVELS, HAND

Ames Co., O.—"RED EDGE"
Failing Co., George E.
National Mine Service Co.
Salem Tool Co.—"BLACK DIAMOND," "RED DEVIL"
Wood Shovel & Tool Co.

SHOVELS, LOADING

American Tractor Corp.—"TERRATRAC"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clark Equipment Co., Construction Machinery Div.
Eimco Corp.
Gar Wood Industries, Inc.
Harnischfeger Corp.—"P&H"
Insley Mfg. Corp.
Koehring Co.
Link Belt Speeder Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.

SHOVELS, POWER

Caterpillar Tractor Co.—"TRAXCAVATOR"

SHOVELS, STRIPPING

American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Harnischfeger Corp.—"P&H"
Insley Mfg. Corp.
Koehring Co.
Link Belt Speeder Corp.
Mahon Co., R. C.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.

SHOWER-ROOM EQUIPMENT

Zurn Mfg. Co., J. Z., American Flexible Coupling Div.

SIEVES, TESTING

Denver Equipment Co.
Fischer Scientific Co.
Newark Wire Cloth Co.
Tyler Co., W. S.

SIGNALS, BELL & HORN

Crouse-Hinds Co.

SILOS, ASH & FLYASH

United Conveyor Corp.

SILOS, COAL & SAND STORAGE

Christian Engineers, J. D.
Fairfield Engineering Co.
Kanawha Mfg. Co.
Koehring Co.
Lippmann Engineering Works
Marietta Concrete Corp.—"MARIETTA"
Neff & Fry Co.

SKIDS, CAR

Miners Hardware Supply

SKIPS, HOISTING

Bartlett, C. O., & Snow Co.
Card, C. S., Iron Works Co.
Christian Engineers, J. D.
Connellsville Mfg. & Mine Supply Co.
Denver Equipment Co.
Hewitt-Robins, Inc.
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Jones Foundry & Machine Co., W. A.
Link-Belt Co.—"LINK-BELT"
Mahon Co., R. C.
Mayo Tunnel & Mine Equipment Co.
Nordberg Mfg. Co.
Stephens-Adamson Mfg. Co.
Vulcan Iron Works
Webb Corp.
Webster Mfg., Inc.
Whiting Corp.

SLIDE RULES

Bruning Co., Inc., Charles—"PICKETT & ECKEL"

SLINGS, BELT

New York Belting & Packing Co.—"ROUGH RIDER"

SLINGS, CHAIN

Republic Steel Co.—"REPUBLIC"

SLINGS, ROPE & CHAIN

American Brake Shoe Co.
American Cable Div., American Chain & Cable Co., Inc.—"ACCO"
American Chain & Cable Co., Inc.
Colorado Fuel & Iron Corp.—"WICKWIRE"
Flocker & Co., John
Ryerson & Son, Inc., Joseph T.
Shaw Box Crane & Hoist Div., Manning, Maxwell & Morse, Inc.—"TIPIT"
Upson-Walton Co.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"WICKWIRE"

SLINGS, WIRE ROPE

Bethlehem Steel Co.
Broderick & Bascom Rope Co.
Leschen Wire Rop Div., H. K. Porter, Inc., of Pittsburgh
Macwhyte Company—"MONARCH," "MACWHYTE," "ATLAS," "DREW," "SAFE-GUARD," "Y-GUARD"
Roebling's Sons Corp., Sub. Colorado Fuel & Iron Corp.
Savage Co., W. J.
Union Wire Rope Corp.—"TUFFY"

SLOPE ROLLERS, BRACKETS, WOOD

Hammond Co., J. V.

SLUSHERS, SCRAPER

Joy Mfg. Co.
Morse Bros. Machinery Co.

SOCKETS, WIRE ROPE

Upson-Walton Co.
Macwhyte Co.

SOLENOIDS

Allen-Bradley Co.
Cheatham Electric Switching Device Co.
Cutler-Hammer, Inc.
General Electric Co., Apparatus Sales Div.
Graybar Electric Co., Inc.

SPAD DRIVERS

American Mine Supply Co.—"AMERICAN"

SPADS

American Mine Supply Co.—"AMERICAN"
Black Diamond Spad Co.
Howells Mining Drill Co.—"HOWELLS"

SPECTACLES, SAFETY

Willson Products Co.

SPEED INCREASERS

Falk Corp.

SPEED REDUCERS

Allis-Chalmers Mfg. Co.
American Pulley Co.—"SHAFT-KING"
Brad Foote Gear Works
Christian Engineers, J. D.
Cleveland Worm & Gear Co.
Cone-Drive Gears, Div. Michigan Tool Co.
Continental Gin Co., Industrial Div.
Delaval Steam Turbine Co.
Dodge Mfg. Co.—"TORQUE ARM"
Farrel-Birmingham Co., Inc.
Foote Bros. Gear & Machine Corp.—"LINE-O-POWER," "HYGRADE," "MAXI-POWER"
Iowa Mfg. Co.
James Gear Mfg. Co., D. O.
Jones Foundry & Machine Co., W. A.
Link-Belt Co.—"LINK-BELT"
National Mine Service Co.
Stephens-Adamson Mfg. Co.
Transall, Inc.
U. S. Electrical Motors, Inc.—"SYNCRO-GEAR"
Worthington Corp.

SPIRALS, COAL

WEMCO Div., Western Machinery Co.—"WEMCO"

SPLICING COMPOUNDS

Plymouth Rubber Co., Inc.—"P. R."

SPRAY COMPOUNDS

Esso Standard Oil Co.
Johnson-March Corp.

SPRAY OILS

American Chemsal Co.—"CHEMSPRAY"
Ashland Oil & Refining Co.—"PERMA-TREAT COAL SPRAY"
Cities Service Oil Co.
Esso Standard Oil Co.
Keenan Oil Co.—"KEENOIL 7"
Sinclair Refining Co.
Sun Oil Co.
Texas Co.
Tide Water Associated Oil Co.

SPRAYING EQUIPMENT, WATER

Plastex Co.—"SWIRL SPRAY"

SPRAYING EQUIPMENT, WATER & COMPOUNDS

Homestead Valve Mfg. Co.
Johnson-March Corp.
Kinney Engineers, Inc., S. P.

SPRAYING EQUIPMENT, OIL

Gray & Co.
Keenan Oil Co.
Sanford-Day Iron Works, Inc.

SPROCKETS

American Manganese Steel Div., American Brake Shoe Co.
Bonded Scale & Machine Co.
Browning Mfg. Co.
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Cincinnati Mine Machinery Co.
Continental Gin Co., Industrial Div.
Diamond Chain Co., Inc.
Fairmont Machinery Co.
Herold Mfg. Co.
Iowa Mfg. Co.
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel Co.
Link-Belt Co.—"LINK-BELT"
McNally Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.
Mosebach Electric & Supply Co.
Morse Chain Co., Borg-Warner Industry
National Mine Service Co.
Pettibone Mulliken Corp.
Transall, Inc.
Taylor-Wharton Iron & Steel Co.
Tool Steel Gear & Pinion Co.
Tracy Co., Bertrand P.
Webb Corp.

Webster Mfg. Inc.
Whitney Chain Co.
Wilmot Engineering Co.

SPROCKETS, COAL CUTTERS

Bowdil Co.
Cincinnati Mine Machinery Co.

STACKERS, RECLAIMERS, COAL

Dravo Corp.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.

STAIR TREADS

Hendrick Mfg. Co.

STARTERS, ENGINE, HYDRAULIC

Hydramotive, Inc.

STEAM CLEANERS, COMPOUNDS

Homestead Valve Mfg. Co.

STEEL, ABRASION-RESISTING

United States Steel Corp.

STEEL, ALLOY

United States Steel Corp.—"USS"

STEEL, HIGH-STRENGTH

United States Steel Corp.—"USS COR-TEN," "USS MAN-TEN," "USS TRI-TEN"
U. S. Steel Supply Div., United States Steel Corp.

STEEL, STAINLESS

United States Steel Corp.—"USS"
U. S. Steel Supply Div., United States Steel Corp.

STEEL, STAINLESS SHAPES

Disston & Sons Inc., Henry

STEEL, TOOL

Disston & Sons Inc., Henry

STOKERS

American Engineering Co.
Auburn Foundry, Inc.
Axeman-Anderson Co.
Canton Stoker Corp.—"VULCAN RAM," "LOSET RAM," "DURAFLEX SCREW"
Carpenter Heating & Stoker Co.
Combustion Engineering, Inc.
Combustion Engineering, Inc., Raymond Div.
Dallas Engineers Inc.
Dayton Automatic Stoker Co.
Fairmont Machinery Co.
Gibraltar Equipment & Mfg. Co.
Hoffman Combustion Engineering Co.
Laclede Stoker Co.
McNally Pittsburg Mfg. Corp.
Pettibone Mulliken Corp.—"STOWE"

STOKERS CHAINGRATE

Laclede Stoker Co.—"LACLEDE"

STOKERS, SPREADER

Laclede Stoker Co.—"LACLEDE-UNIVERSAL"

STOPERS, ROOF-BOLTING

Cleveland Rock Drill Div., Westinghouse Air Brake Co.
Ingersoll-Rand Co.

STOPPINGS, STEEL DEMOUNTABLE

Tri-County Building Service

STOWING MACHINES

Herold Mfg. Co.

STRAINERS, PUMP

Barrett, Haentjens & Co.—"HAZLETON"
Cash, A. W. Co.—"CASH STANDARD"
Failing Co., George E.
Fairmont Machinery Co.
Goyne Pump Co.
Guyan Machinery Co.—"GUYAN"
Kinney Engineers, Inc., S. P.
Zurn Mfg. Co., J. Z.—"LPD"

STRUCTURAL STEEL

Bethlehem Steel Co.
Connellsville Mfg. & Mine Supply Co.
Dravo Corp.
Enterprise Wheel & Car Corp.
Fairmont Machinery Co.
Holmes & Bros., Inc., Robert
Heyl & Patterson, Inc.
Industrial Engineering & Construction Co.
Inland Steel Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Mahon Co., R. C.
McNally Pittsburg Mfg. Co.
Ryerson & Son, Inc., Joseph T.
Prins & Associates, K.
Sheffield Steel Div., Armco Steel Corp.
Thomas Engineering & Construction Co.
Transall, Inc.
Webb Corp.
United States Steel Corp.
U. S. Steel Supply Co. Div., United States Steel Corp.
Vincennes Steel Corp.

SUBSTATIONS, OUTDOOR

Delta-Star Electric Div., H. H. Porter Company, Inc., of Pittsburgh

SUBSTATIONS, UNIT

Allis-Chalmers Mfg. Co.
General Electric Co., Apparatus Sales Div.
Joy Mfg. Co.
Westinghouse Electric Corp.

SUGGESTION SYSTEMS, POSTERS, BOXES, FORMS

Elliott Service Co., Inc., Coal Mine Poster Div.

SUPERVISORY CONTROL SYSTEMS

B-I-F Industries, Inc., Builders-Providence Div.—"SYNCHRO-SCAN"

SURVEYING EQUIPMENT

Berger, C. L., & Sons, Inc.—"BERGER"
Bruning Co., Inc., Charles—"BRUNSON"
Geo-Optic Co., Inc.
Kern Instruments, Inc.
Wild Heerbrugg Instruments, Inc.

SWEATBANDS

American Optical Co.

SWITCH BOARDS

Allis-Chalmers Mfg. Co.
General Electric Co., Trumball Components & Distribution Assemblies Depts.
Graybar Electric Co., Inc.
Industrial Machine & Elec. Co.
Ironton Engine Co.
Lewis Industries, Ltd.
Mosebach Electric & Supply Co.
Ready Power Co.—"READY-POWER"
Square D Co.
Welch Electric Co.

SWITCH BOXES

National Electric Products Co.—"REDEGE"

SWITCH BOXES, HOUSES

Crouse-Hinds Co.
Graybar Electric Co., Inc.
Lewis Industries, Ltd.
Mosebach Electric & Supply Co.
Square D Co.
Welch Electric Co.

SWITCHES, CONVEYOR-CONTROL

Schroeder Brothers

SWITCHES, ELECTRICAL

Allen-Bradley Co.
Anderson Mfg. Co., Albert & J. M.
Arrow Hart & Hegeman Electric Co.
Bryant Electric Co.
Cheatham Electric Switching Device Co.—"HEAVY-DUTY"
Clark Controller Co.
Crouse-Hinds Co.
Cutler-Hammer, Inc.
Delta-Star Electric Div., H. K. Porter Company, Inc., of Pittsburgh
Dooley Bros.
General Electric Co., Apparatus Sales Div.
General Electric Co., Construction Materials Div.
Graybar Electric Co., Inc.
I-T-E Circuit Breaker Co.
Joy Mfg. Co.
Mining Machine Parts, Inc.
Mosebach Electric & Supply Co.
Nachod & U. S. Signal Co.
Ohio Brass Co.
Square D Co.
Welch Electric Co.
Westinghouse Electric Corp.

SWITCHES, ELECTRICAL, MERCURY

Durakool, Inc.

SWITCHES, ELECTRICAL, SAFETY

Arrow Hart & Hegeman Electric Co.
Clark Controller Co.
Crouse-Hinds Co.
Cutler-Hammer, Inc.
Dooley Bros.
Elreco Corp.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Trumball Components & Distribution Assemblies Depts.
Graybar Electric Co.
Joy Mfg. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Square D Co.
Welch Electric Co.
Westinghouse Electric Co.

SWITCHES, LOCOMOTIVE TRANSFER

Post-Glover Electric Co.

SWITCHGEAR & AUXILIARIES

Allis-Chalmers Mfg. Co.
Arrow Hart & Hegeman Electric Co.
Cutler-Hammer, Inc.
Electric Machinery Mfg. Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Trumbull Components & Distribution Assemblies Depts.
Graybar Electric Co., Inc.
I-T-E Circuit Breaker Co.
Joy Mfg. Co.
Square D Co.
Welch Electric Co.

SWIVELS, WIRE-ROPE

Upson-Walton

TABLES, AIR-CLEANING

Daniels Co., Contractors, Inc.
Fairmont Machinery Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

TABLES, COAL-WASHING

Deister Concentrator Co.—"SUPERDUTY DIAGONAL DECK"
Deister Machine Co.—"DEISTER"
Denver Equipment Co.
Fairmont Machinery Co.
Holmes & Bros., Inc., Robert
Linatex Corp. of America
Link-Belt Co.—"LINK-BELT"
Mine & Smelter Supply Co., Marcy Mill Div.—"WELFLEY"

WEMCO Div., Western Machinery Co.—"WEMCO"

TACHOMETERS

Bristol Co.—"BRISTOL'S"
Fischer Scientific Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Hayes Corp.
Ideal Industries Inc.
Martindale Electric Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Reliance Electric & Engineering Co.

TAKEOFFS, POWER

Failing Co., George E.
Four Wheel Drive Auto Co.
Joy Mfg. Co.
Perfection Steel Body Co.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.
Twin Disc Clutch Co.

TAKEUPS, CONVEYOR

American Conveyor Co.
Bartlett, C. O., & Snow Co.
Bearings, Inc.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
Christian Engineers, J. D.
Continental Gin Co., Industrial Div.
Fafnir Bearing Co.
Fairmont Machinery Co.
Hewitt-Robbins, Inc.
Holmes & Bros., Inc., Robert
Jeffrey Mfg. Co.
Jones Foundry & Machine Co., W. A.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link Belt Co.—"LINK-BELT"
Lippman Engineering Works
McNally Pittsburg Mfg. Corp.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Webb Corp.
Webster Mfg., Inc.

TAMPERS, SHOT-HOLE

Hammond Co., J. V.
King Powder Co., Inc.
Salem Tool Co.—"SALEM"

TAMPING PLUGS

National Mine Service Co.—"PERMI-SEAL," "QUICK-SEAL"
Olin Mathieson Chemical Corp.

TAMPING STICKS, WOOD

Hammond Co., J. V.

TANKS

Bethlehem Steel Co.
Black, Sivalls & Bryson, Inc.
Denver Equipment Co.
Enterprise Wheel & Car Corp.
Kanawha Mfg. Co.
Linatex Corp. of America
Lippmann Engineering Works
Mahon Co., R. C.
Prins & Associates, K.
Webb Corp.
U. S. Hoffman Machinery Corp.

TANKS, BOLTED, WELDED

Butler Mfg. Co.

TANKS, CLARIFYING, RECOVERY

McNally Pittsburg Mfg. Corp.

TANKS, RUBBER-LINED

Galigher Co.—"GALIGHER"
Manhattan Rubber Div., Raybestos Manhattan, Inc.

TAPE, FRICTION & RUBBER

Anchor Packing Co.
Dayton Rubber Co.—"HOLFAST"
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.
Graybar Electric Co., Inc.
Ideal Industries, Inc.
Jenkins Bros.
Johns-Manville, Dutch Brand Div.—"DUTCH BRAND"
Johns-Manville—"JOMANCO 4-STAR"
Mosebach Electric & Supply Co.
National Mine Service Co.
New York Belting & Packing Co.—"GREAT SEAL"
Okonite Company—"OKONITE RUBBER TAPE," "MANSON FRICTION TAPE," "OKOLITE HIGH VOLTAGE TAPE," "OKOPRENE WEATHER-RESISTANT TAPE"
Ruberoid Co.
Plymouth Rubber Co., Inc.—"SLIPKNOT," "PLYMOUTH PLASTIC"
Tracy Co., Bertrand P.
United States Rubber Co., Mechanical Goods Div.
West Virginia Armature Co.

TAPE, FRICTION & RUBBER, PLASTIC

Boston Woven Hose & Rubber Co.

TAPE, PLASTIC

Jenkins Bros.

TAPES, MEASURING

Lufkin Rule Co.

TAPS, CABLE & TROLLEY

Duquesne Mine Supply Co.
Elreco Corp.
Flood City Brass & Elec. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.

TELEPHONES, BATTERY

Crouse-Hinds Co.
Graybar Electric Co., Inc.

TELEPHONES, SOUND-POWERED

Crouse-Hinds Co.
Graybar Electric Co., Inc.

TELEPHONES, TROLLEY

Femco, Inc.
Midland Pipe & Supply Co.
Mine Safety Appliances Co.—"MINE-PHONE"
National Mine Service Co.

TELEVISION SYSTEMS

Diamond Power Specialty Co.—"UTILIVUE," "UTILISCOPE"
Femco, Inc.
Graybar Electric Co., Inc.
Motorola Communications & Electronics, Inc.

TEMPERATURE INDICATORS, CONTROLLERS

West Instrument Corp.

TERMINATORS

Delta-Star Electric Div., H. K. Porter Company, Inc., of Pittsburgh

TEST STANDS, HYDRAULIC

Schroeder Brothers

TESTERS, INSULATION

Complete Reading Electric Co., Inc.
Electrical Distributors Co.
Martindale Electric Co.

TESTERS, PORTABLE HYDRAULIC

Schroeder Brothers

TESTERS, RAIL BOND

Baldwin-Lima-Hamilton Corp.
Mosebach Electric Supply Co.
Ohio Brass Co.

THERMOCOUPLES

West Instrument Corp.

THICKENERS

American Well Works
Denver Equipment Co.
Dorr-Oliver, Incorporated—"TORQ"
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Link-Belt Co.—"LINK-BELT"
McNally Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Prins & Associates, K.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
WEMCO Div., Western Machinery Co.—"WEMCO"

THIMBLES, WIRE-ROPE

Upson-Walton Co.

TIE REMOVERS, REPLACERS

Templeton, Kenly & Co.

TIMBER, ALUMINUM

Reynolds Metals Co.

TIMBER, PRESSURE-TREATED

American Lumber & Treating Co.

TIMBER, TREATED

Moss Tie Co., T. J.
Osmose Wood Preserving Co. of America
Republic Creosoting Co.

TIMBER, YIELDING STEEL

Herold Mfg. Co.

TIMBER FRAMERS

Denver Equipment Co.
Silver Engineering Works, Inc.

TIMBER PULLERS

Joy Mfg. Co.

TIMBER-TREATING MATERIALS

Carbolineum Wood Preserving Co.—"CARBOLINEUM"
Dow Chemical Co.
Monsanto Chemical Co.. Organic Chemicals Div.
Osmose Wood Preserving Co. of America

TIMBERING MACHINES

Fletcher & Co., J. H.
Goodman Mfg. Co.
Joy Mfg. Co.
Ruger Equipment, Inc.—"TIMBERLIFT"

TIMERS, ELECTRICAL, MERCURY

Durakool, Inc.

TIPPLES

WEMCO Div., Western Machinery Co.—"WEMCO," "HMS," "MOBIL-MILL"

TIRES, RUBBER

Armstrong Rubber Co.
Firestone Tire & Rubber Co.
Gates Rubber Company
General Tire & Rubber Co.
Goodrich Co., B. F., Tire & Equipment Div.
Goodyear Tire & Rubber Co.
Industrial Wheel Co.—"MINE CUSHION"
Joy Mfg. Co.
Kelly Springfield Tire Co.
Mitchell Industrial Tire, Inc.—"MITCO"
United States Rubber Co., Tire Div.—"U. S. ROYAL," "MINE CUSHION"

TIRES, STEEL

National Mine Service Co.
Penn Machine Co.
Taylor-Wharton Iron & Steel Co.
Tracy Co., Bertrand P.
Webb Corp.

TOOLS, INSTALLATION, COMPRESSION CONNECTORS

Burndy Engineering Co., Inc.—"HYTOOLS," "HYPRESSES"

TOOLS, MECHANICS
Snap-on Tools Corp.—"SNAP-ON"

TOOLS, PRECISION
Lufkin Rule Co.

TOOLS, TRACK
Duquesne Mine Supply Co.
Salem Tool Co.—"SALEM"

TORQUE CONVERTERS
Allison Div., General Motors Corp.—"TORQMATIC"
Twin Disc Clutch Co.

TORQUE DIVIDERS
Timken Detroit Axle Div., Rockwell Spring & Axle Co.

TORQUE LIMITERS
Morse Chain Co.

TORQUE WRENCHES
Bearings, Inc.
Blackhawk Mfg. Co.
Snap-on Tools Corp.—"SNAP-ON"

TOWERS, BARGE UNLOADING
Dravo Corp.

TOWERS, HYDRAULIC
Mobile Aerial Towers, Inc.—"HY-RANGER"

TOWBOATS
Dravo Corp.

TRACK BOLTS
American Tractor Corp.
Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"CF&I"
Gibraltar Equipment & Mfg. Co.
National Mine Service Co.
Oliver Iron & Steel Corp.
Pittsburgh Screw & Bolt Corp.
Ryerson & Son, Inc., Joseph T.
Republic Steel Corp.—"REPUBLIC"
Sheffield Steel Div., Armco Steel Corp.
West Virginia Steel & Mfg. Co.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Co.—"CF&I"

TRACK CLEANERS
American Mine Door Co.—"CANTON"
Homestead Valve Mfg. Co.
Pettibone Mulliken Corp.

TRACK SPIKES
Bethlehem Steel Co.

TRACK SWITCH THROWERS, AC OR DC, ELECTRICAL
Cheatham Electric Switching Device Co.

TRACTOR-COMPRESSOR UNITS
LeRoi Div., Westinghouse Air Brake Co.—"TRACTAIR"

TRACTOR LOADERS
American Tractor Corp.—"TERRATRAC"
Case Co., J. L.
Clark Equipment Co., Construction Machinery Div.
Drott Mfg. Co.—"SKID-SHOVELS," "FOUR-IN-ONE SKID-SHOVELS"
Eimco Corp.
Hough Co., Frank G.—"PAYLOADER"
International Harvester Co.
Jaeger Machine Co.
Oliver Corp.—"OLIVER"
Perfection Steel Body Co.
Pettibone Mulliken Corp.
Tractomotive Corp.

TRACTORS, AUTOMOTIVE HAULAGE
Autocar Div., White Motor Co.
Cline Truck Co.
Federal Motor Truck Co.
International Harvester Co.
Koehring Co.—"DUMPTOR"
Oshkosh Motor Truck, Inc.
Walter Motor Truck Co.

TRACTORS, CRAWLER
Allis-Chalmers Mfg. Co.
American Tractor Corp.—"TERRATRAC"
Caterpillar Tractor Co.—"CATERPILLAR"
Diesel Energy Corp.
Eimco Corp.
Euclid Div., General Motors Corp.
International Harvester Co.
Kloeckner-Humboldt-Deutz AG
Oliver Corp.—"OLIVER"

TRACTORS, UNDERGROUND
Baker-Raulang Co.
Eimco Corp.

TRACTORS, RUBBER-TIRED MINE, BATTERY-POWERED
Kersey Mfg. Co.

TRACTORS, WHEELED
Allis-Chalmers Mfg. Co.
Caterpillar Tractor Co.—"CATERPILLAR"
Diesel Energy Corp.
Hough Co., Frank G.
International Harvester Co.
Kloeckner-Humboldt-Deutz AG
LeTourneau-Westinghouse Corp.—"TOURNATRACTOR"
Oliver Corp.—"OLIVER"

TRAILER AXLES
Timken Detroit Axle Div., Rockwell Spring & Axle Co.

TRAILER DUMP BODIES
Hockensmith Corp.—"PENN"

TRAILERS, DUMP
Marion Metal Products Co.

TRAILERS, FULL & SEMI
Athey Products Corp.
Baughman Mfg. Co.—"HI-SPEED"
Cline Truck Co.
Enterprise Wheel & Car Corp.
Fruehauf Trailer Co.—"FRUEHAUF"
Hercules Steel Products Co.
Mahon Co., R. C.
Sanford-Day Iron Works, Inc.
Truck Engineering Co.
Webb Corp.

TRAILERS, REAR-DUMP
Athey Products Corp.

TRAILERS, SIDE-DUMP
Easton Car & Construction Co.

TRANSFER CASES
Timken Detroit Axle Div., Rockwell Spring & Axle Co.

TRANSFORMERS
Allis-Chalmers Mfg. Co.
Federal Telephone & Radio Corp.
General Electric Co., Apparatus Sales Div.
Hannon & Sons, F. R.—"HANCO"
Hevi-Duty Electric Co.
Kehlman Electric Co.—"SOF-T-KUHL"
Lewis Industries, Ltd.
Moloney Electric Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Rapid Electric Co.
Wagner Electric Corp.
Westinghouse Electric Corp.

TRANSMISSIONS
Allison Div., General Motors Corp.—"TORQMATIC"

TRANSMISSIONS, AUTOMOTIVE
Fuller Mfg. Co.

TRIP LAMPS
Concordia Electric Co.
Mine Safety Appliances Co.

TROLLEY LINE & FEEDER MATERIALS
Duquesne Mine Supply Co.
Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mining Machine Parts, Inc.
Mosebach Electric & Supply Co.
Ohio Brass Co.
West Virginia Armature Co.

TROLLEY FROGS, ELECTRIC
Cheatham Electric Switching Device Co.

TROLLEY GUARDS
Cincinnati Rubber Mfg. Co.
Elreco Corp.—"ELRECO"
Gering Products
Goodrich Co., B. F., Industrial Products Div.
Guyan Machy. Co.—"VISI-GARD"
Mine Safety Appliances Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Quaker Rubber Corp., Div. of H. K. Porter Company, Inc. of Pittsburgh

TROLLEY HARPS, SHOES, SLIDERS
Duquesne Mine Supply Co.
Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Jeffrey Mfg. Co.
Imperial Cantrell Mfg. Co.
Mosebach Electric & Supply Co.
National Mine Service Co.—"BEMECO"
Ohio Brass Co.
West Virginia Armature Co.

TROLLEY POLES, WOOD
Hammond Co., J. V.

TROLLEY-SHOE CONTACTORS
Cheatham Electric Switching Device Co.
Nachod & U. S. Signal Co.

TROLLEY SIGNAL SYSTEMS
Nachod & U. S. Signal Co.

TROLLEY SYSTEMS, INVERTED
Elreco Corp.—"ELRECO"

TROLLEY-TAP FUSES
Trico Fuse Mfg. Co.

TROLLEYS, I-BEAM
Coffing Hoist Div., Duff-Norton Co.

TRUCK AXLES
Cline Truck Co.
Eaton Mfg. Co., Axle Div.
Enterprise Wheel & Car Corp.
Four Wheel Drive Auto Co.
Hendrickson Mfg. Co.
Mack Motor Truck Corp.
Webb Corp.

TRUCK AXLES, DRIVING & NONDRIVING FRONT & REAR
Timken Detroit Axle Div., Rockwell Spring & Axle Co.
Truck Axles, Tandem-Drive, Two-Speed
Eaton Mfg. Co., Axle Div.

TRUCK BODIES
Baughman Mfg. Co.—"HI-SPEED"
Cline Truck Co.
Easton Car & Construction Co.
Enterprise Wheel & Car Corp.
Galion Allsteel Body Co.
Gar Wood Industries, Inc.
Heil Co.
Hercules Steel Products Corp.
Hockensmith Corp.—"PENN"

Mahon Co., R. C.
Marmon-Harrington Co., Inc.
Perfection Steel Body Co.
Truck Engineering Co.

TRUCK BOGIES
Mack Motor Truck Corp.

TRUCK DRIVES, TANDEM-AXLE ETC.
Cline Truck Co.
Enterprise Wheel & Car Corp.
Four Wheel Drive Auto Co.
Hendrickson Mfg. Co.
Mack Motor Truck Corp.
Marmon-Harrington Co., Inc.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.

TRUCKS, AUTOMOTIVE
Autocar Div., White Motor Co.
Chevrolet Motor Div., General Motors Corp.
Cline Truck Co.
Dart Truck Co.
Dodge Truck Div., Chrysler Corp.—"DODGE JOB RATED"
Euclid Div., General Motors Corp.
Federal Motor Truck Co.
Ford Motor Co.—"TRIPLE ECONOMY"
Four Wheel Drive Auto Co.
Hendrickson Mfg. Co.
International Harvester Co., Motor Truck Div.—"INTERNATIONAL"
Koehring Co.—"DUMPTOR"
Mack Motor Truck Corp.
Marmon-Harrington Co., Inc.—"ALL-WHEEL DRIVE"
Oshkosh Motor Truck, Inc.
Reo Motors, Inc.
Walter Motor Truck Co.

TRUCKS, MINE-CAR
National Malleable & Steel Casting Co.—"NATIONAL NC-1"

TUBES RUBBER
Goodrich Co., B. F., Tire & Equipment Div.

TURNBUCKLES
Upson-Walton Co.

UNDERCUTTERS, COMMUTATOR
West Virginia Armature Co.

VACUUM CLEANERS, PLANT
Black & Decker Mfg. Co.
Graybar Electric Co., Inc.
Ideal Industries, Inc.
Martindale Electric Co.
U. S. Hoffman Machinery Corp.

VALVES, ACID-RESISTING
Duriron Co., Inc.

VALVES, AIR
Black, Sivalls Bryson, Inc.
Bristol Co.—"BRISTOL'S"
Crane Co.
Darling Valve & Mfg. Co.
Fairbanks Co.
Fischer & Porter Co.
Fischer Scientific Co.
Grinnell Co.—"GRINNELL-SAUNDERS"
Homestead Valve Mfg. Co.
Hose Accessories Co., LE-HI Div.—"LE-HI"
Jenkins Bros.
Kinney Engineers, Inc., S. P.
Lunkenheimer Co.
Midland Pipe & Supply Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Ohio Brass Co.
Phillips Div., Salem-Brosius, Inc.
Reed Roller Bit Co., Cleco Div.—"DALLETT"
Victor Equipment Co.
Walworth Co.
Williams Valve Co., D. T., Div. of Schaible Co.

VALVES, AIR, STEAM, WATER, OIL, PRESSURE, REGULATOR, RELIEF
Cash Co., A. W.—"CASH STANDARD"

VALVES, BRONZE GLOBE
Lunkenheimer Co.—"LQ 600"

VALVES, BRONZE, IRON, CAST-STEEL, STAINLESS
Jenkins Bros.

VALVES, CHECK
Albert Pipe Supply Co.
ACF Industries
Barrett, Haentjens & Co.—"HAZLETON"
Crane Co.
Darling Valve & Mfg. Co.
Duquesne Mine Supply Co.
Failing Co., George E.
Fairbanks Co.
Flood City Brass & Electric Co.
Goyne Pump Co.
Jeffrey Mfg. Co.
Jenkins Bros.
Kennedy Valve Co.
Kinney Engineers, Inc., S. P.
Ludlow Valve Mfg. Co.
Lunkenheimer Co.
McNally Pittsburgh Mfg. Corp.
Midland Pipe & Supply Co.
Ohio Brass Co.
Pennsylvania Pump & Compressor Co.
R-P-C Valve Div., American Chain & Cable Co., Inc.
Sanford-Day Iron Works, Inc.
Vickers, Inc.
Walworth Co.
Williams Valve Co., D. T., Div. of Schaible Co.
Worthington Corp.

VALVES, CHECK, CORROSION-RESISTANT
Labour Co., Inc.

VALVES, DIAPHRAGM-DISC
Farris Flexible Valve Corp.

VALVES, FOOT & STRAINER
Crane Co.
Duquesne Mine Supply Co.
Failing Co., George E.
Flood City Brass & Elec. Co.
Goodall Rubber Co.
Goyne Pump Co.
Kinney Engineers, Inc., S. P.
Ludlow Valve Mfg. Co.
Midland Pipe & Supply Co.
Sanford-Day Iron Works, Inc.
Walworth Co.

VALVES, GATE
Goyne Pump Co.
Phillips Div., Salem-Brosius, Inc.

VALVES, GLOBE & GATE
Albert Pipe Supply Co.
Crane Co.
Darling Valve & Mfg. Co.
Electric Steel Foundry
Failing Co., George E.
Fairbanks Co.
Jeffrey Mfg. Co.
Jenkins Bros.
Kennedy Valve Co.
Kinney Engineers, Inc., S. P.
Ludlow Valve Mfg. Co.
Lunkenheimer Co.
McNally Pittsburg Mfg. Corp.
Midland Pipe & Supply Co.
Ohio Brass Co.
R-P-C Valve Div., American Chain & Cable Co., Inc.
Walworth Co.
Williams Valve Co., D. T., Div. of Schaible Co.

VALVES, GLOBE, CORROSION-RESISTANT
Labour Co., Inc.

VALVES, LUBRICATED
Homestead Valve Mfg. Co.

VALVES, PINCH
Barrett, Haentjens & Co.—"HAZLETON"
Farris Flexible Valve Corp.
Fischer Scientific Co.
Grinnell Co.—"GRINNELL-SAUNDERS"
Linatex Corp. of America
Midland Pipe & Supply Co.
Mine & Smelter Supply Co. — "MASSCO GRIGSBY"
New York Belting & Packing Co. — "INDESTRUCTIBLE"
Red Jacket Co. — "RED JACKET VALVE"

VALVES, PLASTIC
Lunkenheimer Co. — "LUNCOR"

VALVES, PLUG
Homestead Valve Mfg. Co.
Duriron Co., Inc.

VALVES, PRESSURE REDUCING
Cash Valve Mfg. Corp., A. W.

VALVES, PUMP
Duquesne Mine Supply Co.

VALVES, WATER & STEAM
Homestead Valve Mfg. Co.

VALVES, Y & ANGLE
Duriron Co., Inc.

VARIABLE-SPEED DRIVES
Allis-Chalmers Mfg. Co.
Allis Co., Louis
Cleveland Worm & Gear Co.
Dayton Rubber Co. — "DAYTON"
Graybar Electric Co., Inc.
Link-Belt Co. — "P. I. V."
Lovejoy Flexible Coupling Co. — "LOVEJOY VARIABLE," "SPEED PULLEYS," "SELECTO-SPEED," "VARIABLE SPEED," "TRANSMISSIONS"
Morse Chain Co., a Borg-Warner Industry
Reeves Pulley Co.
Reliance Electric & Engineering Co. — "RELIANCE V*S DRIVE"
Transall, Inc.
U.S. Electrical Motors, Inc. — "VARIDRIVE"
Vickers, Inc.
Worthington Corp.

VARIABLE-SPEED DRIVES, EDDY CURRENT
Dynamatic Div., Eaton Mfg. Co. — "AJUSTO SPEED"

VENTILATING TUBING
American Brattice Cloth Corp. — "MINEVENT," "NEOLON"
Bemis Bros. Bag Co. — "FLEXIPLY"
du Pont de Nemours & Co., E. I. — "VENTUBE"
Flexaust Co. — "FLEXAUST," "PORTOVENT"
Goodrich Co., B. F. — Industrial Products Div.
Joy Mfg. Co.
National Mine Service Co.
Naylor Pipe Co.

VIBRATION TESTS, BLASTING
Vibration Measurement Engineers
White, Harold H.

VIBRATORS, BIN
Neff & Fry Co.

VIBRATORS, HOPPER, BIN, CHUTE, SCREEN
Cleveland Vibrator Co.

WAGONS, HAULING
Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc.

WARNING SIGNALS
Nachod & U.S. Signal Co.

WASHABILITY TESTS
Warner Laboratories

WASHERS, CALCIUM-CHLORIDE
Fuel Process Co.

WASHERS, HEAVY-MEDIA
Colorado Iron Works Co.
Daniels Co., Contractors, Inc.
Davis Co., Nelson L.
Fairmont Machinery Co.
Hewitt-Robins, Inc.
Jeffrey Mfg. Co.
Kinney Engineers, Inc., S. P.
Link-Belt Co. — "LINK-BELT"
Ore & Chemical Corp. — "OCC VESSEL"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Tennant Sons & Co., C., The Sink & Float Div. — "H&H"
Universal Engineering Co.
WEMCO Div., Western Machinery Co. — "WEMCO," "MOBIL-MILL"
Wilmot Engineering Co.

WASHERS, JIG
Fairmont Machinery Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co.—"AIR PULSATED"
McNally Pittsburg Mfg. Co.
Ore Reclamation Co.
Prins & Associates, K.
WEMCO Div., Western Machinery Co.—"WEMCO"
Wilmot Engineering Co.

WASHERS, LAUNDER, TROUGH
Link-Belt Co.—"LINK-BELT"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Prins & Associates, K.
Wilmot Engineering Co.

WASHERS, SAND-FLOTATION
Fairmont Machinery Co.
Marsh Engineering Co., E. F.
United Engineers & Constructors, Inc.

WASHERS, UPWARD-CURRENT
Daniels Co., Contractors, Inc.
Fairmont Machinery Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Wilmot Engineering Co.

WASTE TREATMENT, PROCESSES & EQUIPMENT
American Well Works

WATER NEUTRALIZERS
Allis-Chalmers Mfg. Co.
American Well Works
Water Neutralizing Co.

WATER-RECLAMATION SYSTEMS
Denver Equipment Co.

WATER REPELLENTS
Stonhard Co.—"STONSEAL," "STONTITE"

WEDGE BARS, TOOTH REPOINTING
Stulz-Sickles Co.—"MANGANAL"

WELDERS, ARC
Air Reduction Sales Co. Div., Air Reduction Co., Inc.
American Manganese Steel Div., American Brake Shoe Co.
Caterpillar Tractor Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Guyan Machinery Co.—"BOND," "GUY-AN"
Harnischfeger Corp.—"P&H"
Hobart Bros. Co.—"HOBART"
Lincoln Electric Co.—"SHIELD-ARC," "IDEAL-ARC," "FLEETWELDER"
Linde Air Products Co., Div. of Union Carbide & Carbon Corp.
Metal & Thermit Corp.—"M&T"
Mosebach Elec. & Supply Co.
Ohio Brass Co.
Penn Machine Co.
Smith Co., A. O.
Tweco Products Co.
Westinghouse Electric Corp.
West Virginia Armature Co.

WELDERS, RAIL-BONDING
Post-Glover Electric Co.

WELDING CABLE
General Electric Co., Construction Materials Dept.
Hobart Bros.
Rome Cable Corp.
United States Rubber Co., Electrical Wire & Cable Dept.—"ROYAL"

WELDING CABLE, ALUMINUM
Tweco Products Co.—"TWECO-LITE"

WELDING CARBON PRODUCTS
Helwig Co.
National Carbon Co., Div. Union Carbide & Carbon Corp.—"NATIONAL"

WELDING, CUTTING TORCHES
Air Reduction Sales Co. Div., Air Reduction Co., Inc.
Linde Air Products Co., Div. Union Carbide & Carbon Corp.
Victor Equipment Co.
Westinghouse Electric Corp.

WELDING ELECTRODES
Eutectic Welding Alloys Corp.—"EUTEC-TRODES"
Metal & Thermit Corp.—"MUREX"
Revere Copper & Brass Inc.
Smith Co., A. O.
Stulz-Sickles Co.—"MANGANAL"
Taylor-Wharton Iron & Steel Co.

WELDING ELECTRODES, CARBON
Pure Carbon Co.
Stackpole Carbon Co.

WELDING ELECTRODES, GRAPHITE
National Carbon Co., Div. Union Carbide & Carbon Corp.—"NATIONAL"
Pure Carbon Co.

WELDING ELECTRODES, HOLDERS
Air Reduction Sales Co. Div., Air Reduction Co., Inc.
Crucible Steel Co. of America
Eutectic Welding Alloys Corp.—"EUTEC-TRODES"
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Harnischfeger Corp.—"P&H"
Hobart Bros. Co.—"HOBART"
Lincoln Electric Co.—"FLEETWELD," "JETWELD," "SHIELD-ARC," "STAIN-WELD," "AERISWELD," "PLANEWELD," "SOFTWELD," "FERROWELD," "TOOLWELD"
Mosebach Electric & Supply Co.
Tweco Products Co.—"TWECO"
West Virginia Armature Co.

WELDING FLUXES, ALLOY
Stoody Company—"MAGNECOTE"

WELDING GASES
Air Reduction Sales Co. Div., Air Reduction Co., Inc.
Linde Air Products Co., Div. of Union Carbide & Carbon Corp.
Westinghouse Electric Corp.

WELDING GOGGLES, MASKS
Air Reduction Sales Co. Div., Air Reduction Co., Inc.
American Optical Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.
Hobart Bros. Co.—"HOBART"
Lincoln Electric Co.
Linde Air Products Co., Div. of Union Carbide & Carbon Corp.
Mine Safety Appliances Co.
United States Safety Service Co.
Westinghouse Electric Corp.
Willson Products, Inc.

WELDING GROUND CLAMPS
Tweco Products Co.—"TWECO"

WELDING HELMETS
American Optical Co.

WELDING HOLDERS
Erico Products, Inc.—"CADDY"

WELDING HOSE
Boston Woven Hose & Rubber Co.
Quaker Rubber Corp., Div. H. K. Porter Company Inc., of Pittsburgh

WELDING RECTIFIERS
Hobart Bros.
Lewis Industries, Ltd.

WELDING SHIELDS
Hobart Bros.

WELDING TRANSFORMERS
Hobart Bros.

WELDMENTS
Falk Corp.

WETTING AGENTS
American Cyanamid Co., Mineral Dressing Dept.—"AEROSOL"
Carbide & Carbon Chemicals Co., Div. of Union Carbide & Carbon Corp.
Fischer Scientific Co.
Hercules Powder Co.
Houghton & Co., E. F.—"SURFAX"
Magic Chemical Co.
Michigan Alkali Div., Wyandotte Chemicals Corp.—"KREELON," "PLURONICS"

WHEELS
Gibraltar Equipment & Mfg. Co.

WHEELS, LOCOMOTIVE, STEEL, C. I.
Ironton Engine Co.

WHEELS, MINE CAR, C. I.
ACF Industries, Inc.
American Brake Shoe Co.
Card, C. S., Iron Works Co.
Enterprise Wheel & Car Corp.
Helmick Foundry-Machine Co.
Holmes & Bros., Inc., Robert
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Link-Belt Co.—"LINK-BELT"
McLanahan & Stone Corp.
Sanford-Day Iron Works, Inc. — "S-D FLOATER"
Watt Car & Wheel Co.
Webb Corp.

WHEELS, MINE-CAR, STEEL
American Brake Shoe Co.
Armco Drainage & Metal Products, Inc.
Baldwin-Lima-Hamilton Corp.
Bethlehem Steel Co.
Brad-Foote Gear Works
Card, C. S., Iron Works Co.
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Hockensmith Corp.
Holmes & Bros., Inc., Robert
Indiana Foundry Co.
Link-Belt Co.—"LINK-BELT"
National Malleable & Steel Castings Co.—"NACO"
Pittsburgh Gear Co.

Sanford-Day Iron Works, Inc.—"S-D FLOATER"
Sterling Steel Casting Co.
Taylor-Wharton Iron & Steel Co.
Watt Car & Wheel Co.
Webb Corp.

WHEELS, TROLLEY

Elreco Corp.

WINCHES

Robbins & Meyers, Inc.—"R&M"

WINCHES, CAR PULLERS

Shepherd Niles Crane & Hoist Co.

WIRE, COPPER-COVERED STEEL

Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"

WIRE, ELECTRICAL, INSULATED

Copperweld Steel Co., Wire & Cable Div.

WIRE, ELECTRICAL, TELEPHONE

Copperweld Steel Co., Wire & Cable Div.

WIRE, FEEDER, TROLLEY

Aluminum Co. of America
American Steel & Wire Div., United States Steel Corp.—"TIGER"
Anaconda Wire & Cable Co.
Flocker & Co., John
General Cable Corp.
Holmes & Bros., Inc., Robert
Mosebach Electric & Supply Co.
Roebling's Sons Corp., John A., Subs. the Colorado Fuel & Iron Corp.

WIRE & CABLE, INSULATED

Triangle Conduit & Cable Co.

WIRE CLOTH

Buffalo Wire Works Co., Inc.
Hoyt Woven Wire Cloth Co.—"SUPER-TOUGH," "STAINLESS," "ABRASO"
Newark Wire Cloth Co.

WIRE ROPE & CABLE

American Cable Div., American Chain & Cable Co., Inc.—"TRU-LAY," "LAY-SET"
American Chain & Cable Co., Inc.
American Steel & Wire Div., United States Steel Corp.—"TIGER"
Bergen Wire Rope—"BERCO"
Bethlehem Steel Co.
Broderick & Basco Rope Co.
Colorado Fuel & Iron Corp.—"WICK-WIRE"
Ensign Electric & Mfg. Co.
Failing Co., George E.
Flocker & Co., John
Flood City Brass & Electric Co.
Interstate Equipment Div., Yara Engineering Corp.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"HERCULES RED STRAND"
LeTourneau-Westinghouse Co.
Macwhyte Company—"MONARCH WHY-TE STRAND," "MACWHYTE," "PLA-STEEL," "KILINDO," "HI-LASTIC," "HI-FATIGUE"
Mosebach Electric & Supply Co.
National Mine Service Co.
Rochester Ropes, Inc.
Roebling's Sons Corp., John A., Subs. The Colorado Fuel & Iron Corp.—"ROYAL "BLUE," "BLUE CENTER"
Ryerson & Son, Inc., Joseph T.
Union Wire Rope Corp.—"TUFFY"
West Virginia Armature Co.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"WICKWIRE"
Wire Rope Corp. of America, Inc.—"BROWN STRAND," "WIRECO"

WIRE-ROPE BLOCKS

Upson-Walton Co.

WIRE-ROPE CLAMPS, FITTINGS

Newman Mfg. & Sales Co.—"NEWCO"

WIRE-ROPE CLAMPS, FITTINGS, SOCKETS, ETC.

American Cable Div., American Chain & Cable Co. Inc.
American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
American Steel & Wire Div., United States Steel Corp.—"TIGER"
Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"WICK-WIRE"
Electric Steel Foundry—"LONG-BOWL SOCKET"
Failing Co., George E.
Flocker & Co., John
Laughlin, Thomas, Div. American Hoist & Derrick Co.
Leschen Wire Rope Div., H. K. Porter, Inc.
Macwhyte Company
Mosebach Electric & Supply Co.
Ohio Brass Co.
Rochester Ropes, Inc.
Roebling's Sons Corp., John A., Sub. The Colorado Fuel & Iron Corp.
Sauerman Bros., Inc.
Union Wire Rope Corp.—"NEWCO"
Upson-Walton Co.
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.—"WICKWIRE"
Wire Rope Corp. of America, Inc.—"BROWN STRAND," "WIRECO"

WIRE-ROPE DRESSING, LUBRICANTS

American Cable Div., American Chain & Cable Co., Inc.
American Steel & Wire Div., United States Steel Corp.—"TIGER"
D-A Lubricant Co. Inc.
Dixon Crucible Co., Joseph
Leschen Wire Rope Div., H. K. Porter, Inc.—"LEPRO"
Macwhyte Company—"MACWHYTE"
Rochester Ropes, Inc.
Sinclair Refining Co.
Swan Finch Oil Corp.—"MOTUL HIPEN #5"
Texas Co.

WIRE-ROPE SOCKETS

Macwhyte Company

WIRE-ROPE SWAGED ASSEMBLIES

Upson-Walton Co.

WIRING DEVICES

Bryant Electric Co.—"BRYANT"

WOOD PRESERVATIVES

Carbolineum Wood Preserving Co.
Osmose Wood Preserving Co. of America

WORMS AND GEARS

Cleveland Worm & Gear Co.

WRENCHES, BIT

Goodman Mfg. Co.
Joy Mfg. Co.
Salem Tool Co.—"SALEM"
Snap-on Tools Corp.—"SNAP-ON"
Tracy Co., Bertrand P.

WRENCHES, HOPPER DOORS

Advance Car Mover Co., Inc.—"ADVANCE"

WRENCHES, IMPACT

Bearings, Inc.
Blackhawk Mfg. Co.
Chicago Pneumatic Tool Co.
Mall Tool Co.
Porter, Inc., H. K.—"IMPAK-DRIVER"
Snap-on Tools Corp.—"SNAP-ON"
Thor Power Tool Co.

WRENCHES, REVERSIBLE RATCHET

Greene, Tweed & Co.—"FAVORITE"

WRENCHES, TORQUE

Bearings, Inc.
Blackhawk Mfg. Co.
Gibraltar Equipment & Mfg. Co.
Snap-on Tools Corp.—"SNAP-ON"

WRENCHES, TRACK

Gibraltar Equipment & Mfg. Co.

YO-YOS, HYDRAULIC

Stamler Co., W. R.

BLACK-FACED TYPE indicates manufacturers with special product-information advertisements in this issue. To locate the advertisement of a specific manufacturer, consult the advertising Index on p 242 of this issue or turn to the Directory of Manufacturers beginning on the next page.

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Directory of Manufacturers

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Page number or numbers are given following the address in each such instance.

A

ACF Industries, Inc., 30 Church St., New York 7, N. Y.
Acker Drill Co., 725 W. Lackawanna Ave., Scranton 3, Pa.
Acme Machinery Co., P. O. Box 1169, Williamson, W. Va. ADV. p 141
Advance Car Mover Co. Inc., Box 536, Appleton, Wis.
Aerial Surveys, Inc., 4614 Prospect Ave., Cleveland, Ohio
Aeroquip Corp., 300 S. East Ave., Jackson, Mich. ADV. p 174
Aero Service Corp., 210 E. Courtland St., Philadelphia 20, Pa.
Ahlberg Bearing Co., 3025 W 47th St., Chicago 32, Ill.
Airmite-Midwest, Inc., 119 N. Chestnut St., Du Quoin, Ill.
Air Reduction Sales Co. Div., Air Reduction Co., Inc., 60 E. 42nd St., New York, N. Y.
Ajax Flexible Coupling Co., 100 English St., Westfield, N. Y.
Albert Pipe Supply Co., Berry & N. 13th Sts., Brooklyn, N. Y.
Aldrich Pump Co., 1 Pine St., Allentown, Pa.
Alemite Div. of Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago 14, Ill.
Alford, Newell G., 509 Oliver Bldg., Pittsburgh 22, Pa.
Allegheny Ludlum Steel Corp., Carmet Div., Detroit 20, Mich. ADV. p. 158
Allen-Bradley Co., 1305 S. 1st St., Milwaukee 4, Wis.
Allen & Garcia Co., 332 S. Michigan Ave., Chicago 4, Ill.
Allen-Sherman-Hoff Pump Co., 259 E. Lancaster Ave., Wynnewood, Pa.
Allis-Chalmers Mfg. Co., 968 S. 70th St., Milwaukee 1, Wis. ADV. opposite p 136
Allis-Chalmers Mfg. Co., Buda Div., 154 & Commercial Sts., Harvey, Ill.
Allis Co., The Louis, 427 E. Stewart St., Milwaukee 7, Wis.
Allison Div., General Motors Corp., Indianapolis 6, Ind.
Alloy Rods Co., York, Pa.
Aluminum Company of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa.
American Air Filter Co., Inc., 215 Central Ave., Louisville 8, Ky. ADV. p 189
American Blower Corp., Detroit 32, Mich.
American Brake Shoe Co., 230 Park Ave., New York 17, N. Y.
American Brattice Cloth Corp., Warsaw, Ind.. ADV. p 188
American Cable Div., American Chain & Cable Co., Inc., Wilkes-Barre, Pa.
American Chemsol Co., Coraopolis, Pa.
American Conveyor Co., 2133 S. Christiana Ave., Chicago 23, Ill.
American Crucible Prods. Co., Oberlin Rd., Lorain, Ohio
American Cyanamid Co., Mineral Dressing Dept., 30 Rockefeller Plaza, New York 20, N. Y. ADV. opposite p 152
American Cyanamid Co., Explosives Dept., 30 Rockefeller Plaza, New York 20, N. Y.
American Engineering Co., Aramingo Ave. & Cumberland St., Philadelphia 25, Pa.
American Hoist & Derrick Co., 63 S. Robert St., St. Paul 1, Minn.
American LaFrance Corp., 160 E. LaFrance St., Elmira, N. Y.
American Manganese Steel Div., American Brake Shoe Co., Chicago Heights, Ill. ADV. p 170
American-Marsh Pumps, Inc., 59 Capitol Ave., N. E., Battle Creek, Mich.
American Mine Door Co., 2057 Dueber Ave. S. W., Canton 6, Ohio ADV. p 173
American Mine Supply Co., 404 Frick Bldg., Pittsburgh 19, Pa.
American Oil Co., American Bldg., Baltimore, Md.
American Optical Co., 14 Mechanic St., Southbridge, Mass.
American Pulley Co., 4200 Wissahickon Ave., Philadelphia 29, Pa.
American Pulverizer Co., 1249 Macklind Ave., St. Louis 10, Mo. ADV. p 179
American Steel Foundries, 400 N. Michigan, Chicago 11, Ill.
American Steel & Wire Div., United States Steel Corp., Rockefeller Bldg., Cleveland 13, Ohio
American Tractor Corp., Churubusco, Ind.
American Well Works, 100 N. Broadway, Aurora, Ill.
American Wheelabrator & Equipment Corp., 311 S. Byrkit St., Mishawaka, Ind.
Ames Co., O., Parkersburg, W. Va.
Ammann, Jack, Photogrametric Engineers, Broadway at 10th, San Antonio, Tex.
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y. ADV. p 137
Anchor Packing Co., 401 N. Broad St., Philadelphia 8, Pa.
Anderson Mfg. Co., Albert & J. M. 289 A. St., Boston 10, Mass.
Ansonia Wire & Cable Co., The, 63 Main St., Ansonia, Conn.
Ansul Chemical Co., Marinette, Wis.
Armco Drainage & Metal Products, Inc., Middletown, Ohio
Armstrong-Bray & Co., 5366 Northwest Highway, Chicago 30, Ill. ADV. p 180
Armstrong Rubber Co., West Haven, Conn.
Arrow Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford 6, Conn.
Arrowhead Steel Building, Inc., 366 Garfield Ave., Duluth, Minn.
Ashland Oil & Refining Co., Ashland, Ky.
Athey Products Corp., 5631 W. 65 St., Chicago 38, Ill.
Atlas Car & Mfg. Co., 1140 Ivanhoe Rd., Cleveland 10, Ohio
Atlas Powder Co., Wilmington 99, Del. ADV. p 138
Auburn Foundry, Inc., Auburn, Ind.
Aurora Pump Div., New York Air Brake Co., 100 Loucks St., Aurora, Ill.
Austin Powder Co., Rockefeller Bldg., Cleveland 13, Ohio
Austin-Western Co., Construction Equipment Div., Baldwin - Lima - Hamilton Corp., Aurora, Ill.
Autocar Div., White Motor Co., Exton, Pa.
Axeman-Anderson Co., 233 West St., Williamsport 3, Pa.

B

Baker-Raulang Co., 1250 W. 80 St., Cleveland 2, Ohio
Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div., Lima, Ohio ADV. p 187
Bantam Bearings Div., Torrington Co., 3702 W. Sample St., South Bend 21, Ind.
Barber-Greene Co., 400 N. Highland Ave., Aurora, Ill. ADV. p 147
Barnes Mfg. Co., 651 N. Main St., Mansfield, Ohio
Barrett, Haentjens & Co., Hazleton, Pa.
Bartlett, C. O. & Snow Co., 6200 Harvard Ave., Cleveland 5, Ohio
Baton & Co., Geo. S., 1100 Union Trust Bldg., Pittsburgh 19, Pa. ADV. p 193
Baughman Mfg. Co., Jerseyville, Ill.
Bausch & Lomb Optical Co., 804 St. Paul St., Rochester 2, N. Y.
Bay City Shovels, Inc., Bay City, Mich.
Bearings, Inc., 3634 Euclid Ave., Cleveland 15, Ohio
Bearing Service Co., 4650-52 Baum Blvd., Pittsburgh 13, Pa.
Beaver Pipe Tools, Inc., 310 Dana Ave., NE, Warren, Ohio
Bemis Bro. Bag Co., 408 Pine St., St. Louis 2, Mo.
Bergen Wire Rope, Lodi, N. J.
Berger, C. L. & Sons, Inc., 31 St. James Ave., Boston 16, Mass.
Berry Div., Oliver Iron & Steel Corp., Oliver Bldg., Pittsburgh 22, Pa.
Bete Fog Nozzle, Inc., 309 Wells St., Greenfield, Mass.
Bethlehem Steel Company, Bethlehem, Pa.
B-I-F Industries, Inc., Builders-Providence, Inc., Div., 395 Harris Ave., Providence 1, R. I.
B-I-F Industries, Inc., Omega Machine Co. Div., 395 Harris Ave., Providence 1, R. I.
B-I-F Industries, Inc., Proportioneers, Inc., Div., 395 Harris Ave., Providence 1, R. I.
Bigelow Liptak Corp., 2550 West Grand Blvd., Detroit 8, Mich.
Bin-Dicator Co., 13946 Kercheval St., Detroit 15, Mich. ADV. p 192
Bird Machine Co., South Walpole, Mass.
Bituminous Casualty Co., Iowa-Illinois Bldg., Rock Island, Ill.
Bixby-Zimmer Engr. Co., 961 Abington St., Galesburg, Ill. ADV. p 169
Black & Decker Mfg. Co., Towson 4, Md.
Black Diamond Spad Co., 2108 Stratford Rd., Richmond 25, Va.
Blackhawk Mfg. Co., 5325 W. Rogers St., Milwaukee 46, Wis.
Black, Sivalls Bryson, Inc., 7500 E. 12th St., Kansas City, Mo.
Bonded Scale & Machine Co., 2195 S. 3rd St., Columbus, Ohio
Bone Dry Shoe Mfg. Co., Neosho, Mo. and Tacoma, Wash.
Boston Woven Hose & Rubber Co., P. O. Box 1071, Boston, 3, Mass.
Bowdil Co., Boylan Ave., Canton, Ohio ADV. p 150
Bower Roller Bearing Co., 3040 Hart Ave., Detroit 14, Mich.
Bowser, Inc., 1302 E. Creighton Ave., Fort Wayne, Ind.
Brad-Foote Gear Works, Neville Island, Pittsburgh 25, Pa.
Brake Engineering Co., 1510 Main St., Wheeling, W. Va.
Bristol Co., The, Waterbury 20, Conn.
Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo.
Brooks Oil Co., 934 Ridge Ave., Pittsburgh 12, Pa.
Brookville Locomotive Works, Steele Blvd., Brookville, Pa.
Browning Dust Collector Co., P. O. Box 133, Hampden, W. Va.
Browning Mfg. Co., Maysville, Ky.
Bruning Co., Inc., Charles, 4702 Montrose Ave., Chicago 41, Ill.
Brunner & Lay, Inc., 9300 W. King St., Franklin Park, Ill.
Brunson Inst. Co., 1405 Walnut, Kansas City, Mo.
Bryant Electric Co., The, Box D, Barnum Station, Bridgeport 2, Conn.

Bucyrus-Erie Co., South Milwaukee, Wis. ADV. p 135
Buell Engineering Co. Inc., 70 Pine St., New York 5, N. Y.
Buffalo Scale Co., Inc., 46 Letchworth St., Buffalo 13, N. Y.
Buffalo Wire Works Co., Inc., 320 Terrace St., Buffalo 2, N. Y.
Bullard Co., E. D., 275 Eighth St., San Francisco, Calif.
Burndy Engineering Co., Inc., Norwalk, Conn.
Bussmann Mfg. Co., 2536 W. University St., St. Louis 7, Mo.
Butler Mfg. Co., 7400 E. 13th St., Kansas City 26, Mo.
Byers Co., A. M., Clark Bldg., Pittsburgh 22, Pa.

C

Cambridge Wire Cloth Co., Cambridge, Md.
Campbell Co., E. K., 1809 Manchester, Kansas City 26, Mo.
Canton Stoker Corp., 741 Andrew Place S. W. Canton, Ohio
Carbide & Carbon Chemicals Co., A Div. of Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N. Y.
Carbolineum Wood Preserving Co., 526 W. Highland Ave., Milwaukee, Wis.
Carboloy Dept. of General Electric Co., Box 237, Roosevelt Park Annex, Detroit 32, Mich.
Card Iron Works Co., C. S., P. O. Box 117, Denver 1, Colo.
Cardox Corp., 307 N. Michigan Ave., Chicago 1, Ill.
Carey Mfg. Co., Philip, Lockland, Cincinnati, Ohio
Carlon Products Corp., 10225 Meech Ave., Cleveland, Ohio
Carlyle Rubber Co., 64 Park Pl., New York, N. Y.
Carpenter Heating & Stoker Co., 2135 St. Clair Ave., Cleveland, Ohio
Case Co., J. I., 700 State St., Racine, Wis.
Cash Co., A. W., P. O. Box 551, Decatur, Ill.
Cash Valve Mfg. Corp., A. W., 666 E. Wabash, Decatur, Ill.
Castanoli, Alder F., 1302 W. Va. Bldg., Huntington, W. Va.
Caterpillar Tractor Co., Peoria 8, Ill.
C & D Batteries, Inc., Conshohocken, Pa.
Central Mine Equipment Co., 6200 N. Broadway, St. Louis 15, Mo. ADV. p 180
Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Ill.
Centric Clutch Co., U. S. Route 9 at Main St., P. O. Box 175, Woodbridge, N. J. ADV. p 176
Centrifugal & Mech. Industries, Inc., 146 President St., St. Louis 18, Mo.
Century Electric Co., 1806 Pine St., St. Louis 3, Mo.
Chain Belt Co., 4786 W. Greenfield Ave., Milwaukee 1, Wis.
Champ Industries, Div. of Hose Accessories Co., 1927-41 Atlantic St., Philadelphia 32, Pa.
Cheatham Elec. Switching Device Co., 4780 Crittenden Dr., Louisville 9, Ky. ADV. p 192
Chelsea Fan & Blower Co., 639 South Ave., Plainfield, N. J.
Chevrolet Motor Div., General Motors Corp., General Motors Bldg., Detroit 2, Mich.
Chicago Eye Shield Co., 2304 Warren Blvd., Chicago, Ill.
Chicago Perforating Co., 2445 W. 24th Pl., Chicago 8, Ill.
Chicago Pneumatic Tool Co., 6 E. 44th St., New York N. Y.
Christian Engineers, J. D., 480 Potrero Ave., San Francisco 10, Calif.
Cincinnati Electrical Tool Co., 2692 Madison Rd., Cincinnati 8, Ohio
Cincinnati Mine Machinery Co., 2980 Spring Grove Ave., Cincinnati 25, Ohio ADV. p 162
Cincinnati Rubber Mfg. Co., Franklin Ave., Cincinnati 12, Ohio
Cities Service Oil Co., 70 Pine St., New York, N. Y.
Clarage Fan Co., 619 Porter St., Kalamazoo 16, Mich.
Clark Controller Co., 1146 E. 152nd St., Cleveland, Ohio
Clark Equipment Co., Construction Machinery Div., P. O. Box 599, Benton Harbor, Mich.
Clarkson Mfg. Co., Nashville, Ill.
Cleco Div., Reed Roller Bit Co., P. O. Box 2119, Houston 1, Texas
Cleveland Rock Drill Div., Westinghouse Air Brake Co., 12500 Berea Rd., Cleveland 11, Ohio ADV. p 129
Cleveland Vibrator Co., 2828 Clinton Ave., Cleveland, Ohio
Cleveland Wire Cloth & Mfg. Co., 3573 E. 78th St., Cleveland 5, Ohio
Cleveland Worm & Gear Co., 3260 E. 80th St., Cleveland 4, Ohio
Cline Truck Co., 1116 Campbell St., Kansas City, Mo.
Coast Metals Inc., Redneck Ave., Little Ferry, N. J.
Cobra Metal Hose Div., D. K. Mfg. Co., 4640 W. 54th St., Chicago 32, Ill.
Coffing Hoist Div., Duff-Norton Co., 800 Walter St., Danville, Ill.
Collyer Insulated Wire Co., 249 Roosevelt Ave., Pawtucket, R. I.
Colorado Fuel & Iron Corp., Continental Oil Bldg., Denver 1, Colo.
Colorado Iron Works Co., 1624 17th St., Denver 2, Colo.
Columbia-Southern Chemical Co., Sub. of Pittsburgh Plate Glass Co., One Gateway Center, Pittsburgh 22, Pa.
Combustion Engineering, Inc., 200 Madison Ave., New York 16, N. Y.
Combustion Engineering, Inc., Raymond Div., 1315 N. Branch St., Chicago 22, Ill. ADV. p 185
Commercial Shearing & Stamping Co., Youngstown, Ohio
Commercial Testing & Engrg. Co., 228 N. LaSalle St., Chicago, Ill.
Complete Reading Electric Co., Inc., 100 S. Jefferson St., Chicago, Ill.; and Complete Reading Electric Co., Inc. of Ohio, 1437 St. Clair Ave., Cleveland, Ohio
Compton Inc., P. O. Box 1946, Clarksburg, W. Va.
Concordia Electric Co., 1521 Saw Mill Run Blvd., Pittsburgh 10, Pa.
Cone-Drive Gears, Div. of Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
Construction Machinery Co., Box 120, Waterloo, Iowa
Continental Electric Co., 325 Ferry St., Newark 5, N. J.
Continental Gin Co., Industrial Div., P. O. Box 2614, Birmingham 2, Ala.
Continental Motors Corp., Muskegon, Mich.
Continental Rubber Works, 1933 Liberty St., Erie 6, Pa.
Convair Inc., P. O. Box 9671, Pittsburgh 26, Pa.
Cooke-Wilson Elec. Supply Co., 3000 Oakhurst Rd., Pittsburgh 34, Pa.
Cooper Split Roller Bearing Corp., 2021 Milford Dr., Pittsburgh 34, Pa.
Copperweld Steel Co., Wire & Cable Div., Glassport, Pa.
Coppus Engrg. Corp., 344 Park Ave., Worcester 2, Mass.
Cornell-Dubilier Electric Corp., 333 Hamilton Blvd., South Plainfield, N. J.
Cornish Wire Co., Inc., 50 Church St., New York 7, N. Y.
Cowin & Co., Inc., #1 18th St., SW, Birmingham, Ala. ADV. p 193
Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.
Crescent Belt Fastener Co., 480 Lexington Ave., New York, N. Y.
Crouse-Hinds Co., Wolf & Seventh North Sts., Syracuse 1, N. Y.
Crucible Steel Co. of America, Oliver Bldg., Pittsburgh, Pa.
Crusher Engineering Div., Poor & Co., 400 Architects' Bldg., 117 S 17th St., Philadelphia 3, Pa.
Cummins Engine Co., Inc., Columbus, Ind.
Cutler-Hammer, Inc., 315 N. 12th St., Milwaukee 1, Wis.
Cutter Bit Service Co., Christopher, Ill.; and P. O. Box 533, Huntington, W. Va.

D

Dallas Engineers Inc., Coal-O-Matic Div., Main St., Trucksville, Pa.
D-A Lubricant Co. Inc., W 29 St., & the Canal, Indianapolis 23, Ind.
Daly Ticket Co., 506-08 Vandalia St., Collinsville, Ill.
Daniels Co., Contractors, Inc., 22 N Fifth St., Indiana, Pa.
Daniels, Inc., C. R. 75 West St., New York 6, N. Y.
Darling Valve & Mfg. Co., Foot of Walnut St., Williamsport, Pa.
Dart Truck Co., 2623 Oak St., Kansas City, 8, Mo.
Davenport Besler Corp., 2305 Rockingham Rd., Davenport, Iowa
Davey Compressor Co., 600 Franklin Ave., Kent, Ohio ADV. p 182
Davis, Co., Nelson L., 343 S. Dearborn St., Chicago, Ill.
Dayton Automatic Stoker Co., 30 Deeds Ave., Dayton, Ohio
Dayton Rubber Co., 2342 W. Riverside Ave., Dayton 1, Ohio
Dean Brothers Pumps, Inc., 323 W. Tenth St., Indianapolis 7, Ind.
Deister Concentrator Co., 901 Glasgow Ave., Fort Wayne 1, Ind.
Deister Machine Co., 1933 E. Wayne St., Ft. Wayne 4, Ind.
DeLaval Steam Turbine Co., Trenton 2, N. J.
Delta-Star Electric Div., H. K. Porter Co., Inc., of Pittsburgh, 2437 Fulton St., Chicago 12, Ill.
Deming Co., 42 Broadway, Salem, Ohio
Denver Equipment Co., P. O. Box 5268, Denver 17, Colo.
Detroit Diesel Engine Div., General Motors Corp., 13400 West Outer Dr., Detroit 28, Mich. ADV. p 159
Diamond Chain Co. Inc., 402 Kentucky Ave., Indianapolis 7, Ind.
Diamond Crystal Salt Co., St. Clair, Mich.
Diamond Mfg. Co., Wyoming, Pa.
Diamond Power Specialty Co., Lancaster, Ohio
Diesel Energy Corp., 82 Beaver St., New York, N. Y.
Dietzgen Co., Inc., Eugene, 218 E 23rd St., New York 10, N. Y.
Differential Steel Car Co., Box 238, Findlay, Ohio ADV. p 188
Dings Magnetic Separator Co., 4720 W. Electric Ave., Milwaukee, Wis.
Disston & Sons, Inc., Henry, Unruh & Milnor St., Philadelphia 35, Pa.
Dixon Crucible Co., Joseph, Monmouth & Wayne St., Jersey City 3, N. J.
Dodge Mfg. Corp., South Union St., Mishawaka, Ind. ADV. p 160
Dodge Truck Div., Chrysler Corp., 21500 Mound Rd., Detroit 31, Mich.
Dooley Bros., 1201 S. Washington St., Peoria, Ill. ADV. p 178

Dorr-Oliver Incorporated, Barry Pl., Stamford, Conn.
Dow Chemical Co., Hopkins Bldg., Midland, Mich.
Dow Corning Corp., Midland, Mich.
Dowty Mining Equipment, 25 Beaver St., New York 4, N. Y.
Dravo Corp., Neville Island, Pittsburgh 25, Pa.
Dresser Mfg. Div., Dresser Industries, Inc., Bradford, Pa.
Drott Mfg. Co., 3841 W. Wisconsin Ave., Milwaukee 8, Wis.
Ducon Co., 154 E. Second St., Mineola, N. Y.
Duff Norton Co., 2709 Preble Ave., Pittsburgh 30, Pa. ADV. p 152
duPont de Nemours & Co. Inc., E. I., Wilmington 98, Dela.
Duquesne Mine Supply Co., Pittsburgh 9, Pa.
Durakool, Inc., 1010 N. Main St., Elkhart, Ind.
Duriron Co., Inc., 450 N. Findlay St., Dayton 1, Ohio
Dynamatic Div., Eaton Mfg. Co., 3307-14th Ave., Kenosha, Wis.

E

Eagle Iron Works, P. O. Box 934, Des Moines 4, Iowa
Easton Car & Construction Co., Easton, Pa.
Eaton Mfg. Co., Axle Div., 739 E. 140th St., Cleveland, Ohio
Economy Fuse & Mfg. Co., 2717 N. Greenview Ave., Chicago 14, Ill.
Edison Storage Battery Div., Thomas A. Edison, Inc., Lakeside Ave., West Orange, N. J.
Eimco Corp., Salt Lake City 10, Utah
Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N. J.
Elastic Stop Nut Corp. of America, A.G.A. Div., Elizabeth, N. J.
Electrical Distributors Co., Liberty Trust Bldg., Philadelphia, Pa.
Electric Controller & Mfg. Co., 4516 Lee Rd., Cleveland 28, Ohio
Electric Machinery Mfg. Company, 800 Central Ave., Minneapolis 13, Minn.
Electric Prods. Co., 1725 Clarkstone Rd., Cleveland 12, Ohio
Electric Steel Foundry, 2141 N. W. 25th Ave., Portland 10, Ore.
Electro Dynamic Div., General Dynamics, 163 Avenue A, Bayonne, N. J.
Elliott Co., 900 N. Fourth Ave., Jeannette, Pa.
Elliott Service Co., Inc., 30 N. MacQuesten Pkwy., Mt. Vernon, N .Y.
Elreco Corp., 2900 Cormany Ave., Cincinnati 25, Ohio
Ensign-Bickford Co., Simsbury, Conn.
Ensign Electric & Mfg. Co., 914 Adams Ave., Huntington, W. Va.
Enterprise Wheel & Car Corp., Bristol, Va. ADV. p 181
Erico Products Inc., 2070 E 61st Place, Cleveland, Ohio
Eriez Mfg. Co., 215 Magnet Dr., Erie, Pa.
Esso Standard Oil Co., 15 W 51st St., New York 19, N. Y.
Euclid Div., General Motors Corp., 1361 Chardon Rd., Cleveland 17, Ohio
Eutectic Welding Alloys Corp., 40-40 172nd St., Flushing 58, N. Y.
Evanson, Auchmuty & Summers, 2720 Koppers Bldg., Pittsburgh 19, Pa.
Exide Industrial Div., Electric Storage Battery Co., 42 S. 15th St., Philadelphia 2, Pa. ADV. p 241

F

Fafnir Bearing Co., 37 Booth St., New Britain, Conn.
Failing Co., George E., Enid, Okla.
Fairbanks Co., 393 Lafayette St., New York, N. Y.
Fairbanks-Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill.
Fairchild Aerial Surveys, Inc., 224 E. 11th St., Los Angeles 15, Calif. ADV. p 193
Fairfield Engineering Co., 324 Barnhart St., Marion, Ohio
Fairmont Machinery Co., Fairmont, W. Va.
Falk Corp., 3057 W. Canal St., Milwaukee 8, Wis.
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Farris Flexible Valve Corp., 463 Commercial Ave., Palisades Park., N. J.
Farval Corp., 3260 E. 80th St., Cleveland 4, Ohio ADV. p 171
Federal-Mogul Service, 11031 Shoemaker, Detroit 13, Mich.
Federal Motor Truck Co., Div. of Napco Industries, Inc., 5780 Federal Ave., Detroit 9, Mich.
Federal Telephone & Radio Co., 100 Kingsland Rd., Clifton, N. J.
Femco, Inc., Irwin, Pa. ADV. p 192
Fetterman Engineering Co., 1004 Jtwn. Bank & Trust Bldg., Johnstown, Pa. ADV. p 193
Firestone Tire & Rubber Co., Akron 17, Ohio
Firth Sterling, Inc., 3113-15 Forbes St., Pittsburgh 30, Pa.
Fischer & Porter Co., 505 Warminster Rd., Hatboro, Pa.
Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.
Fletcher & Co., J. H., 707 W. 7th St., Box 353, Huntington, W. Va.; or 332 S. Michigan Ave., Chicago 4, Ill. ADV. p 145
Fletcher, J. H., 332 S. Michigan Ave., Chicago 4, Ill.
Flexaust Co., 100 Park Ave., New York 17, N. Y.
Flexible Steel Lacing Co., 4607 Lexington St., Chicago 44, Ill. ADV. p 190
Flexible Tubing Corp., Guilford, Conn.; Los Angeles 64, Calif.
Flocker & Co., John, 644 Grant St., Pittsburgh 19, Pa.
Flood City Brass & Elec. Co., Johnstown, Pa.
Flower Mfg. Co., D. B., 1217 Spring Garden St., Philadelphia 23, Pa.
Foote Bros. Gear & Machine Corp., 4545 S. Western Blvd., Chicago 9, Ill.
Ford Motor Co., P. O. Box 658, Dearborn, Mich.
Ford Motor Co., Industrial Engine Dept., P. O. Box 598, Dearborn, Mich.
Foster Co., L. B., P. O. Box 1647, Pittsburgh 30, Pa.
Foster Wheeler Corp., 165 Broadway, New York, N. Y.
Four Wheel Drive Auto Co., Clintonville, Wis.
Foxboro Co., Foxboro, Mass.
Franklin Plastics, Inc., Franklin, Pa.
Frick-Gallagher Mfg. Co., 110 South Michigan Ave., Wellston, Ohio
Fruehauf Trailer Co., 10940 Harper Ave., Detroit 32, Mich.
Fuel Process Co., 900 "D" Street, So. Charleston, W. Va. ADV. p 163
Fuller Mfg. Co., 1419 N. Burdick St., Kalamazoo, Mich.
Fulton Bag & Cotton Mills, P. O. Box 1726, Atlanta 1, Ga.
Fyr-Fyter Co., 221 Crane St., Dayton 1, Ohio

G

Galigher Co., 545 West 8th S., P. O. Box 209, Salt Lake City 10, Utah
Galion Allsteel Body Co., 605 S. Market St., Galion, Ohio
Galion Iron Wks. & Mfg. Co., Galion, Ohio
Gardner Denver Co., Quincy, Ill.
Garlock Packing Co., 402 E. Main St., Palmyra, N. Y.
Gar Wood Industries Inc., Wayne, Mich.
Gates Rubber Co., 999 S. Broadway, Denver 17, Colo.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Apparatus Sales Div., 1 River Rd., Schenectady 5, N. Y.
General Electric Co., Communication Equipment, Electronics Park, Syracuse, N. Y.
General Electric Co., Construction Materials Div., Bridgeport 2, Conn.
General Electric Co., Lamp Div., Nela Park, Cleveland, Ohio
General Electric Co., Trumbull Components and Distribution Assemblies Depts., 41 Woodford Ave., Plainville, Conn.
General Mills, Inc., 400 Second Ave., South, Minneapolis, Minn.
General Motors Corp., New Departure Div., Bristol, Conn.
General Scientific Equipment Co., 27th & Huntingdon Sts., Philadelphia 32, Pa.
General Splice Corp., 15 Whitehall St., New York, N. Y.
General Tire & Rubber Co., 1708 Englewood Ave., Akron, Ohio
Geo-Optic Co., Inc., 170 Broadway, New York 38, N. Y.
Gering Products, Kenilworth, N. J.
Gibralter Equip. & Mfg. Co., P. O. Box 304, Alton, Ill.
Gilson Screen Co., 110 Center St., Malinta, Ohio
Goodall Rubber Co., Whitehead Rd., Trenton, N. J.
Goodman Mfg. Co., 4834 S. Halsted St., Chicago 9, Ill.
Goodrich Co., B. F., Industrial Products Div., 500 S. Main St., Akron 18, Ohio
Goodrich Co., B. F. Tire & Equipment Div., 500 S. Main St., Akron 18, Ohio
Goodyear Tire & Rubber Co. Inc., 1144 E. Market St., Akron, Ohio
Gorman Rupp Co., Mansfield, Ohio
Gould-National Batteries, Inc., Trenton 7, N. J.
Goulds Pumps, Inc., Seneca Falls, N. Y.
Goyne Pump Co., Ashland, Pa.
Graybar Electric Co., Inc., 420 Lexington Ave., New York 17, N. Y. ADV. p 154
Gray & Co. Inc., 60 11th Ave. N. E., Minneapolis 13, Minn.
Greene, Tweed & Co., North Wales, Pa.
Greensburg Machinery Co., Greensburg, Pa.
Grinnell Co., 260 W. Exchange St., Providence 1, R. I.
Gruendler Crusher & Pulverizer Co., 2919 N. Market St., St. Louis 6, Mo.
Gulf Oil Corp.—Gulf Refining Co., 1822 Gulf Bldg., Pittsburgh 30, Pa.
Gundlach Machine Co., T. J., Div. of J.M.J. Industries, Inc., 226 Centreville Ave., Belleville, Ill. ADV. p 186
Gunite Concrete & Construction Co., 1301 Woodswether Rd., Kansas City 6, Mo.
Gurley, W. & L. E., 514 Fulton St., Troy, N. Y.
Gustin-Bacon Mfg. Co., 210 W. 10th St., Kansas City, Mo.
Guyan Machinery Co., 755 Stratton, Logan, W. Va.
G & W Electric Specialty Co., 7782 Dante Ave., Chicago 19, Ill.

H

Hackbridge & Hewittic Electric Co. Ltd., P. O. Box 234, Pittsburgh 30, Pa.
Haiss Div., George, Pettibone, Mulliken Co., 350 Fifth Ave., New York, N. Y.
Hamilton Rubber Mfg. Corp., 100 Meade St., Trenton 3, N. J.
Hammond Co., J. V., Spangler, Pa.
Hannon & Sons, F. R., 1605 Waynesburg Rd., Canton, Ohio
Hardinge Co., Inc., 240 Arch St., York, Pa.
Harnischfeger Corp., Milwaukee 46, Wis.

Harnischfeger Corp., P&H Diesel Engine Div., 500 S. Main St., Crystal Lake, Ill.
Harrington & King Perforating Co., 5655 Fillmore St., Chicago 44, Ill.
Hartzell Propeller Fan Co. Div., Castle Hill Corp., P. O. Box 909, Piqua, Ohio
Hauck Mfg. Co., 124-136 Tenth St., Brooklyn 15, N. Y.
Hawthorne, Inc., Herb J., Box 7366, Houston 8, Texas
Haynes Stellite Co., a Div. of Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N. Y.
Hays Corp., 742 E. 8th St., Michigan City, Ind.
Heil Co., 3000 Montana Ave., Milwaukee 1, Wis.
Heinemann Elec. Co., 98 Plum St., Trenton 2, N. J.
Heintz Mfg. Co., 13110 Enterprise, Cleveland 11, Ohio
Helicoid Gage Div., American Chain & Cable Co., Inc., Bridgeport 2, Conn.
Helwig Co., 2544 N. 30th St., Milwaukee 10, Wis.
Helmick Foundry-Machine Co., P. O. Box 71, Fairmont, W. Va.
Hendrick Mfg. Co., Carbondale, Pa.
Henrickson Mfg. Co., 8001 W. 47th St., Lyons, Ill.
Hendrix Mfg. Co., Mansfield, La.
Hercules Motors Corp., 101 11th St., S. E., Canton 2, Ohio
Hercules Powder Co., 936 King St., Wilmington 99, Del.
Hercules Steel Products Co., Galion, Ohio
Herold Mfg. Co., 215 Hickory St., Scranton 5, Pa.
Hevi-Duty Electric Co., 4212 W. Highland Blvd., Milwaukee 1, Wis.
Hewitt-Robins Inc., 666 Glenbrook Rd., Stamford, Conn. ADV. p 140
Heyl & Patterson, Inc., 55 Fort Pitt Blvd., Pittsburgh 22, Pa. ADV. p 130
H. & L. Tooth Co., 1540 S. Greenwood Ave., Montebello, Calif. ADV. p 161
Hobart Bros., Troy, Ohio
Hockensmith Corp., Penn, Pa.
Hoffman Brothers Drilling Co., Punxsutawney, Pa.
Hoffman Combustion Engineering Co., 710 Marquette Bldg., Detroit 26, Mich.
Holmes & Bros., Inc., Robert, 510 Junction Ave., Danville, Ill.
Holub Industries, 416 DeKalb Ave., Sycamore, Ill.
Homelite Corp., 75 Riverdale Ave., Port Chester, N. Y.
Homer Mfg. Co., Inc., Dept. 59, Lima, Ohio
Homestead Valve Mfg. Co., Coraopolis, Pa.
Hose Accessories Co., Le-Hi Div., 17th St. & Lehigh Ave., Philadelphia 32, Pa.
Hossfeld Mfg. Co., Prospecting Drill Div., Winona, Minn.
Hough Co., Frank G., 735 Sunnyside Ave., Libertyville, Ill.
Houghton & Co., E. F., 303 W. Lehigh Ave., Philadelphia 33, Pa.
Howe Scale Co., Inc., Rutland, Vt.
Howells Mining Drill Co., 301-303 W. Main St., Plymouth, Pa.
Hoyt Wire Cloth Co., Lancaster, Pa.
Huber-Warco Co., Marion, Ohio
Hughes Tool Co., 300 Hughes St., Houston, Tex.
Hulburt Oil & Grease Co., Trenton & Castor Aves., Philadelphia 34, Pa.
Hyatt Bearings Div., General Motors Corp., Harrison, N. J.
Hydramotive Inc., 6723 Denison Ave., Cleveland 2, Ohio
Hyster Co., 2902 N. E. Clackamas St., Portland 8, Ore.

I

Ideal Industries, Inc., 1020 Park Ave., Sycamore, Ill.
Ilg Electric Ventilating Co., 2850 N. Pulaski Rd., Chicago 41, Ill.
Illinois Powder Mfg. Co., 506 Olive St., St. Louis 1, Mo.
Illinois Zinc Co., 2959 W. 47th St., Chicago 32, Ill,
Imperial-Cantrell Mfg. Co., Box 538, Jellico, Tenn.
Indiana Foundry Co., Indiana, Pa.
Industrial Brownhoist Corp., Bay City, Mich.
Industrial Engr. & Construction Co., P. O. Box 446, Fairmont, W. Va.
Industrial Machine & Elec. Co., P. O. Box 1107, Morgantown, W. Va.
Industrial Rubber Products Co., 815 Court St., Charleston, W. Va.
Industrial Wheel Co., 24141 Ann Arbor Trail, Dearborn 6, Mich.
Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y. ADV. p 156, 157
Inland Steel Co., 38 S. Dearborn St., Chicago 3, Ill.
Insley Mfg. Corp., P. O. Box 167, Indianapolis, Ind.
Insul-Mastic Corp. of America, 7750 W. 61st Pl., Summit, Ill.
International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill.
International Harvester Co., Motor Truck Div., 180 N. Michigan Ave., Chicago 1, Ill.
International Salt Co., Inc., Scranton 2, Pa.
Interstate Equipment Div., Yara Engineering Corp., 18 W. Jersey St., Elizabeth 4, N. J.
Iowa Mfg. Co., 916 16th St. N. E., Cedar Rapids, Iowa
Ironton Engine Co., Farmingdale, N. J. ADV. p 142
Irwin Foundry & Mine Car Co., Irwin, Pa.
I-T-E Circuit Breaker Co., 19th & Hamilton Sts., Philadelphia 30, Pa.

J

Jacuzzi Bros., Inc., Richmond, Calif.
Jaeger Machine Co., 550 W. Spring St., Columbus, Ohio
James Gear Mfg. Co., D. O., 1114 W. Monroe, Chicago 7, Ill.
Jeffrey Mfg. Co., 922 N. 4th St., Columbus 16, Ohio
Jenkins Bros., 100 Park Ave., New York 17, N. Y.
Jesco Lubricants Co., P. O. Box 7331, Kansas City 16, Mo.
Johns-Manville, 22 E. 40th St., New York 16, N. Y.
Johns-Manville Dutch Brand Div., 7800 S. Woodlawn Ave., Chicago 19, Ill.
Johnson Bronze Co., 492 S. Mill St., New Castle, Pa.
Johnson Co., R. G., Washington Trust Bldg., Washington, Pa.
Johnson-March Corp., 1724 Chestnut St., Philadelphia 3, Pa.
Johnson Plastic Corp., Box 312, Chargrin Falls, Ohio
Jones Foundry & Machine Co., W. A., 4401 W. Roosevelt Rd., Chicago 24, Ill.
Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa. ADV. p 139, 153, Third Cover
Joy Mfg. Co., Oliver Bldg., Pittsburgh 22, Pa. ADV. p 131, 132, 133, 134
Joyce Cridland Co., 2027 E. First St., Dayton 3, Ohio
Judsen Rubber Works, Inc., 4107 W. Kinzie St., Chicago 24, Ill.

K

Kanawha Mfg. Co., 1520 Dixie St., Charleston 26, W. Va.
Keasbey & Mattison Co., Ambler, Pa.
Keenan Oil Co., Parkway Dr., Cincinnati, Ohio
Kelly Springfield Tire Co., Cumberland, Md.
Kennametal, Inc., Mining Div., Bedford, Pa. ADV. opposite p 144
Kennedy Valve Co., Elmira, N. Y.
Kennedy Van Saun Mfg. & Engrg. Corp., 2 Park Ave., New York 16, N. Y.
Kensington Steel Co., 505 E. Kensington Ave., Chicago 28, Ill.
Kerite Co., The, 30 Church St., New York 7, N. Y.
Kern Instruments, Inc., 120 Grand St., White Plains, N. Y.
Kersey Mfg. Co., Inc., P. O. Box 151, Bluefield, Va. ADV. p 164
Keuffel & Esser Co., Adams & Third Sts., Hoboken, N. J.
Keystone Carbon Co., 1933 State St., St. Marys, Pa.
Keystone Lubricating Co., 21st & Clearfield Sts., Philadelphia 32, Pa.
Kidde & Co., Walter, 257 Main St., Belleville 9, N. J.
King Powder Co. Inc., 1703 First National Bank Bldg., Cincinnati 1, Ohio
Kinney Engineers, Inc., S. P., 201 Second Ave., Carnegie, Pa.
Kirk & Cowin, #1 18th St. SW, Birmingham, Ala. ADV. p 193
Kloeckner-Humboldt-Deutz AG, c/o Diesel Energy Corp., 82 Beaver St., New York 5, N. Y.
Koehring Co., 31st St. & Concordia Ave., Milwaukee 10, Wis.
Koppers Co., Inc., Metal Products Div., 200 Scott St., Baltimore 30, Md.
Koppers Co., Inc., Wood Preserving Div., Pittsburgh 19, Pa.
Kremser & Sons, Inc., Frank A., 3435 N. Fifth St., Philadelphia, Pa.
Kuhlman Elec. Co., 26th & Jefferson Sts., Bay City, Mich.
K. W. Battery Co., 3555 Howard St., Skokie, Ill.

L

Laboratory Equipment Corp., St. Joseph, Mich.
LaBour Co., Inc., 1607 Sterling Ave., Elkhart, Ind.
Laclede Stoker Co., 4438 Hunt Ave., St. Louis 10, Mo.
Lancaster Pump & Mfg. Co., Inc., 1340 Manheim Pike, Lancaster, Pa.
Laubenstein Mfg. Co., Ashland, Pa.
Laughlin, Thomas, Div. of American Hoist & Derrick Co., 143 Fore St., Portland 6, Me.
Layne & Bowler, Inc., Box 6697 Hollywood Sta., Memphis 8, Tenn.
Lecco Machinery & Engineering Co., New Airport Rd., Bluefield, W. Va.
Lee-Norse Co., Charleroi, Pa.
Leetonia Tool Co., Leetonia, Ohio
Lehigh Safety Shoe Co., Inc., 1st & Minor Sts., Emmaus, Pa.
Leland Electric Co. Div., American Machine & Foundry Co., 1501 Webster St., Dayton 1, Ohio
Le Roi Div., Westinghouse Air Brake Co., 1706 S. 68th St., Milwaukee 14, Wis.
Leschen Wire Rope Div., H. K. Porter Company, Inc., 2727 Hamilton Ave., St. Louis 12, Mo.
LeTourneau-Westinghouse Co., 2301 N. Adams St., Peoria, Ill.
Lewis Industries Ltd., 580 Whittier St., New York 59, N. Y.
Liberty Powder Co., Subsidiary of Olin Mathieson Chemical Corp., 600 Grant St., Pittsburgh 19, Pa.
Linatex Corp. of America, Vernon Ave., Rockville, Conn.
Lincoln Electric Co., 22801 St. Clair Ave., Cleveland, Ohio
Lincoln Engineering Co., 5701 Natural Bridge, St. Louis 20, Mo. ADV. p 151

Linde Air Products Co., a Div. of Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N. Y.
Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill.
Link-Belt Speeder Corp., 1201 Sixth St., S. W., Cedar Rapids, Iowa
Lippmann Engrg. Works, 4603 W. Mitchell St., Milwaukee, Wis.
Littlewood Herbert S., R. D. #3, Irwin, Pa.
Loftus Corp., Peter F., First Natl. Bank Bldg., Pittsburgh 22, Pa.
Long Co., P. O. Box 331, Oak Hill, W. Va. ADV. p 143
Longyear Co., E. J., 1700 Fesbay Tower, Minneapolis 2, Minn. ADV. p 193
Louisville Dryer Div., General American Transportation Corp., 139 S. Fourth St., Louisville, Ky.
Lovejoy Flexible Coupling Co., 4890 W. Lake St., Chicago, Ill.
Lubriplate Div., Fiske Brothers Refining Co., 129 Lockwood St., Newark 5, N. J.
Ludlow Saylor Wire Cloth Co., 634 S. Newstead, St. Louis 10, Mo.
Ludlow Valve Mfg. Co., P. O. Box 388, Troy 1, N. Y.
Lufkin Rule Co., 1730 Hess Ave., Saginaw, Mich.
Lug-All Co., 355 Lancaster Ave., Haverford, Pa.
Lunkenheimer Co., P. O. Box 360, Cincinnati 14, Ohio

M

Mack Truck Motor Corp., 350 Fifth Ave., New York 1, N. Y. ADV. p 146
Macwhyte Company, 2931 14th Ave., Kenosha, Wis.
Magic Chemical Co., 121 Crescent St., Brockton 2, Mass.
Magnetic Engineering & Mfg. Co., Van Houten Ave., Clifton, N. J.
Mahon Co., R. C., P .O. Box 4666, Detroit 34, Mich.
Mall Tool Co., 7740 S. Chicago Ave., Chicago 19, Ill.
Manhattan Rubber Div., Raybestos Manhattan, Inc., 42 Townsend St., Passaic, N. J.
Manheim Mfg. & Belting Co., 469 Steigel St., Manheim, Pa.
Manitowoc Engineering Corp., S. Sixteenth St., Manitowoc, Wis.
Manu-Mine Research & Development Co., P. O. Box 167, Reading, Pa.
Marathon Coal Bit Co., P. O. Box 529, Montgomery, W. Va.
Marietta Concrete Corp., Box 356, Marietta, Ohio
Marion Handle Mills, Inc., Marion, Va.
Marion Metal Prods. Co., Chaney Ave., Marion, Ohio
Marion Power Shovel Co., Marion, Ohio
Marland One-Way Clutch Co., LaGrange, Ill.
Marlin Rockwell Corp., 402 Chandler St., Jamestown, N. Y.
Marlow Pumps, 548 Greenwood Ave., Ridgewood, N. J.
Marmon-Herrington Co. Inc., 1511 W. Washington St., Indianapolis 7, Ind.
Marsh Engineering Co., E. F., 4324 W. Clayton Ave., St. Louis 10, Mo.
Martindale Electric Co., 1307 Hird Ave., Cleveland 7, Ohio ADV. p 184
Marvel Engineering Co., 7227 N. Hamlin Ave., Chicago 45, Ill.
Master Bronze Powder Co., 5009 Calumet Ave., Hammond, Ind.
Mayhew Supply Co., Inc., P. O. Box 7726, 4700 Scyene Rd., Dallas, Texas
Mayo, Robert S., Lancaster, Pa. ADV. p 193
Mayo Tunnel & Mine Equipment Co., Lancaster, Pa.
McGill Mfg. Co., Inc., Valparaiso, Ind.
McLanahan & Stone Corp., Holidaysburg, Pa.
McLaughlin Mfg. Co., Inc., 801 E. Cass St., Joliet, Ill.
McNally-Pittsburg Mfg. Corp., 307 W. Third St., Pittsburg, Kan. ADV. opposite p 128
Mechanical Industries, Inc., 541 Wood St., Pittsburgh 22, Pa.
Meckum Engr. Co., 53 W. Jackson Blvd., Chicago 3, Ill.
Meissner Engineers, Inc., John F., 308 W. Washington St., Chicago 6, Ill. ADV. p 193
Merrick Scale Mfg. Co., 184 Autumn St., Passaic, N. J.
Metal Carbides Corp., 107 E. Indianola Ave., Youngstown, Ohio
Metal & Thermit Corp., 100 E. 42nd St., New York 17, N. Y.
Metallizing Engrg. Co., Inc., 1101 Prospect Ave., Westbury, N. Y.
Mexico Refractories Co., Mexico, Mo.
Mica Insulator Co., 797 Broadway, Schenectady, N. Y.
Michigan Alkali Div., Wyandotte Chemicals Corp., Wyandotte, Mich.
Michigan Pipe Co., 6581 Mill St., Gagetown, Mich.
Michigan Wire Cloth Co., 2100 Howard St., Detroit 16, Mich.
Midland Pipe & Supply Co., 2829 S. 61st St., Chicago, Ill.
Miners' Hardware Supply, 523 Brushton Ave., Pittsburgh 21, Pa. ADV. p 192
Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa. ADV. p 148, 149
Mine & Smelter Supply Co., Marcy Mill Div., P. O. Box 5270 Terminal Annex, Denver 17, Colo.
Mining Machine Parts, Inc., 2701 St. Clair Ave., Cleveland, Ohio
Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne & Windrim Ave., Philadelphia 44, Pa.
Minneapolis-Moline Co., P. O. Box 1050, Minneapolis 1, Minn.
Mitchell Industrial Tire, Inc., Box 468, Chattanooga, Tenn.
Mobile Aerial Towers, Inc., 1730 N. Harrison St., Fort Wayne, Ind.
Mobile Drilling Co. Inc., 960 N. Pennsylvania St., Indianapolis 4, Ind.
Moloney Electric Co., 5390 Bircher Blvd., St. Louis 20, Mo.
Monsanto Chemical Co., Organic Chemicals Div., 800 N. 12 Blvd., St. Louis 1, Mo.
Moore Co., 1036 Quarrier St., Charleston, W. Va.
Morris Machine Works, Baldwinsville, N. Y. ADV. p 2
Morse Bros. Machinery Co., 2900 Brighton Blvd., Denver, Colo.
Morse Chain Co., A Borg-Warner Industry, Ithaca, N. Y.
Morton Salt Co., 120 S. LaSalle St., Chicago 3, Ill.
Mosebach Elec. & Supply Co., 1115 Arlington Ave., Pittsburgh 3, Pa.
Moss Tie Co., T. J., 700 Security Bldg., St. Louis 2, Mo.
Motorola Communications & Electronics, Inc., 4501 W. Augusta Blvd., Chicago 51, Ill.
Mott Core Drilling Co., 830 Eighth Ave., Huntington 17, W. Va. ADV. p 193
Murphy Diesel Co., 5317 W. Burnham St., Milwaukee, Wis.
Myers-Whaley Co., Box 789, Knoxville, Tenn.

N

Nachod & U. S. Signal Co., 4777 Louisville Ave., Louisville 9, Ky. ADV. p 192
Nagle Pumps, Inc., 1249 Center St., Chicago Heights, Ill.
National Carbon Co., a Div. of Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N. Y.
National Electric Coil Co., 800 King Ave., Columbus, Ohio
National Elec. Products Co., 140 Stanwix St., Pittsburgh 22, Pa.
National Filter Media Corp., 1717 Dixwell Ave., New Haven 14, Conn.
National Malleable & Steel Casting Co., 10600 Quincy Ave., Cleveland, Ohio ADV. p 167
National Mine Service Co.—All-State Div., Logan, W. Va.; Anthracite Div., Forty Fort, Pa.; Ashland Div., Ashland, Ky.; Bemeco Div., Beckley, W. Va.; Ky.-Va. Div., Jenkins, Ky.; Western Ky. Div., Madisonville, Ky.; Whiteman Div., Indiana, Pa.
National Powder Co., Eldred, Pa.
Naylor Pipe Co., 1230 E. 92nd St., Chicago 19, Ill.
Neff & Fry Co., Camden, Ohio
New Era Engineering Co., Dept. G-76, 458 W. 29th St., Chicago 16, Ill.
Newark Wire Cloth Co., 370 Verona Ave., Newark 4, N. J.
Newcomer Products, 512 Franklin Ave., Pittsburgh 12, Pa.
Newman Mfg. & Sales Co., 3636 Main St., Kansas City 11, Mo.
New York Air Brake Co., The, 230 Park Ave., New York 17, N. Y.
New York Belting & Packing, 1 Market St., Passaic, N. J.
Nolan Co., Bowerston, Ohio
Norma-Hoffman Bearing Corp., Stamford, Conn.
Nordberg Mfg. Co., 3073 S. Chase Ave., Milwaukee 1, Wis. ADV. Fourth Cover
Northwest Engineering Co., 135 S. LaSalle St., Chicago 3, Ill.
Norton Co., 1 New Bond St., Worcester 6, Mass.

O

Ohio Brass Co., Mansfield, Ohio
Ohio Carbon Co., 12508 Berea Rd., Cleveland 11, Ohio
Ohio Oil Co., Findlay, Ohio
Okonite Company, 5519 Canal St., Passaic, N. J.
Old Republic Insurance Co., (Formerly Coal Operators Casualty Co.), 414 W. Pittsburgh St., Greensburg, Pa.
Olin Mathieson Chemical Corp., Explosives Div., East Alton, Ill.
Oliver Corp., 400 W. Madison, Chicago 6, Ill.
Oliver Iron & Steel Corp., South Tenth & Muriel Sts., Pittsburgh 3, Pa.
Orange Roller Bearing Co., Inc., 557 Main St., Orange, N. J.
Ore & Chemical Corp., 80 Broad St., New York, N. Y.
Orefraction Inc., 7425 Thomas St., Pittsburgh 8, Pa.
Ore Reclamation Co., 313 Wall St., Joplin, Mo.
Orton Crane & Shovel Co., 608 S. Dearborn St., Chicago 5, Ill.
Oshkosh Motor Truck Inc., Oshkosh, Wis.
Osmose Wood Preserving Co., 980 Ellicott St., Buffalo 9, N. Y.

P

Page Engineering Co., Clearing P. O., Chicago 38, Ill. ADV. p 168
Page Steel & Wire Div., American Chain & Cable Co., Inc., Monessen, Pa.
Painut Co., 31 Cordier St., Irvington 11, N. J. ADV. p 186
Pangborn Corp., 670 Pangborn Blvd., Hagerstown, Md.
Paris Mfg. Co., Paris, Ill. ADV. p 191

Pattin Mfg. Co., Marietta, Ohio
Penn Machine Co., Johnstown, Pa.
Pennsylvania Drilling Co., 1201 Chartiers Ave., Pittsburgh 20, Pa.
Pennsylvania Crusher Div., Bath Iron Works Corp., 323 S. Matlack St., West Chester, Pa. ADV. p 196
Penna. Electric Coil Corp. 1301 Saw Mill Run Blvd., Pittsburgh 26, Pa.
Penna Pump & Compressor Co., Easton, Pa.
Pennsylvania Refining Co., Butler, Pa.
Perfection Steel Body Co., Galion, Ohio
Peters, Chester M. F., 930 E. Third South, Salt Lake City, Utah ADV. p 193
Peterson Filters & Engineering Co., 137 Social Hall Ave., Salt Lake City 1, Utah
Pettibone Mulliken Corp., 4710 W. Division St., Chicago 51, Ill.
Pfister Co., Inc., J. B., 662 Ohio St., Terre Haute, Ind.
Phillips Div., Salem-Brosius, Inc., Box 2222, Pittsburgh 30, Pa.
Phoenix Metal Products, 4715 N. 27th St., Milwaukee, Wis.
Pierce Management Corp., Scranton 3, Pa. ADV. p 193
Pioneer Engineering Works Inc., 1515 Central Ave., Minneapolis 13, Minn.
Pitman Mfg. Co., 300 W. 79th Terrace, Kansas City, Mo.
Pittsburgh Corning Corp., 1 Gateway Center, Pittsburgh 22, Pa.
Pittsburgh Gear Co., Neville Island, Pittsburgh 25, Pa.
Pittsburgh Plate Glass Co., One Gateway Center, Pittsburgh 22, Pa.
Pittsburgh Screw & Bolt Corp., P. O. Box 1708, Pittsburgh 30, Pa.
Plastex Co., 402 Mt. Vernon Ave., Columbus 3, Ohio
Plymouth Locomotive Works, Div of the Fate-Root Heath Co., Plymouth, Ohio
Plymouth Rubber Co. Inc., Canton, Mass.
Porter, Inc., H. K., Somerville 43, Mass.
Post-Glover Electric Co., 221 W. Third St., Cincinnati 2, Ohio
Prins & Associates, K., Wellston, Ohio
Productive Equipment Corp., 2926 W. Lake St., Chicago 12, Ill.
Prox Co., Inc., Frank, 1201 S. First St., Terre Haute, Ind.
Pulmosan Safety Equipment Co., 644 Pacific St., Brooklyn 17, N. Y.
Pure Carbon Co., 441 Hall Ave., St. Mary's, Pa.
Pure Oil Co., 35 E. Wacker Dr., Chicago 1, Ill.

Q

Quaker Rubber Corp., Div. of H. K. Porter Company, Inc. of Pittsburgh, Tacony & Comly Sts., Philadelphia 24, Pa.

R

Radio Corp. of America, Engineering Products Div., Camden 2, N. J.
Radio Corp. of America, Inspection & Control 15-1, Camden 2, N. J.
Rapid Electric Co., 2881 Middletown Rd., Bronx 61, N. Y.
Read, Davis, 120 S. LaSalle St., Chicago, Ill. ADV. p 193
Ready Power Co., 11231 Freud Ave., Detroit, Mich.
Red Jacket Co., Inc., 500 Bell Ave., Carnegie, Pa.
Reeves Pulley Co., 1225 7th St., Columbus, Ind.
Reich Bros. Mfg. Co., 1439 Ash St., Terre Haute, Ind.
Reid Belt & Rubber Co., 363 Bluefield Ave., Bluefield, W. Va.
Reintjes Co., George P., 2517 Jefferson St., Kansas City 6, Mo.
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Remington Arms Co., Inc., 939 Barnum Ave., Bridgeport 2, Conn.
Remington Rand, Div. of Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.
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Republic Steel Corp., Republic Bldg., Cleveland 1, Ohio
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Rice Pump & Machine Co., Belgium, Wis.
Ridge Equipment Co., Fallentimber, Pa.
Robbins & Meyers, Inc., 1345 Lagonda Ave., Springfield, Ohio
Roberts & Schaefer Co., Subsidiary of Thompson-Starrett Co., Inc., 130 N. Wells St., Chicago, Ill. ADV. p 144
Robinson & Robinson, Union Bldg., Charleston, W. Va. ADV. p 193
Robinson Ventilating Co., Zelienople, Pa.
Rochester Ropes, Inc., Culpeper, Va.
Rockbestos Products Corp., 285 Nicholl Ave., New Haven 4, Conn.
Roebling's Sons Corp., John A., Sub. of The Colorado Fuel & Iron Corp., 640 S. Broad St., Trenton 2, N. J.
Rogers Bros. Corp., Albion, Pa.
Rollway Bearing Co., Inc., 541 Seymour St., Syracuse 4, N. Y.
Rome Cable Corp., 330 Ridge St., Rome, N. Y. ADV. p 243
Roots-Connersville Blower, Div. of Dresser Industries, Inc., 900 W. Mount St., Connersville, Ind.
R-P-C Valve Div., American Chain & Cable Co., Inc., Reading, Pa.
Ruberoid Co., 500 Fifth Ave., New York 36, N. Y.
Ruger Equipment, Inc., 615 W. 4th St., Uhrichsville, Ohio
Rust-Oleum Corp., 2425 Oakton St., Evanston, Ill.
Rydin Railway Equip. Co., Railway Exch. Bldg., Chicago 4, Ill.
Ryerson & Son, Inc., Joseph T., 16th & Rockwell Sts., Chicago, Ill.

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Salem Tool Co., 767 S. Ellsworth Ave., Box 235, Salem, Ohio ADV. p 180
Sanford-Day Iron Works, Inc., P. O. Box 1511, Knoxville 9, Tenn.
Sauerman Bros. Inc., 620 S. 28th Ave., Bellwood, Ill.
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Shepard Niles Crane & Hoist Corp., Montour Falls, N. Y.
Sight Feed Generator Co., West Alexandria, Ohio
Silver Engineering Works, Inc., 3309 Blake St., Denver 5, Colo. ADV. p 177
Simonds Saw & Steel Co., Fitchburg, Mass.
Simplex Wire & Cable Co., 79 Sidney St., Cambridge 39, Mass.
Simplicity Engineering Co., Durand 16, Mich.
Sinclair Refining Co., 600 Fifth Ave., New York, N. Y.
SKF Industries, Inc., P. O. Box 6731, Philadelphia 32, Pa.
Smith Co., A. O., 3533 N. 27th St., Milwaukee 1, Wis.
Smith Engineering Works, 502 E. Capitol Dr., Milwaukee, Wis.
Snap-on Tools Corp., Kenosha, Wis.
Snap-Tite, Inc., Union City, Pa.
Socony Mobil Oil Co., 26 Broadway, New York 4, N. Y.
Solvay Sales Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.
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Speer Carbon Co., St. Marys, Pa.
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Stamler Corp., W. R., Paris, Ky. ADV. p 166
Standard Carbon Co., P. O. 49, Steubenville, Ohio
Standard Oil Co. (Indiana), 910 S. Michigan Ave., Chicago 80, Ill.
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Torrington Co., 59 Field St., Torrington, Conn.
Trabon Eng. Co., 1814 E. 40th St., Cleveland 3, Ohio
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Transall, Inc., 109 N. 11th St., Birmingham, Ala.
Traylor Engineering & Mfg. Co., Allentown, Pa.
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Tyler Co., W. S., 3615 Superior Ave., Cleveland 14, Ohio
Tyson Bearing Corp., Subsidiary of SKF Industries, Inc., Massillon, Ohio

U

Union Switch & Signal, Div. of Westinghouse Air Brake Co., Pittsburgh 18, Pa.
Union Wire Rope Corp., 2100 Manchester Ave., Kansas City 26, Mo.
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United States Rubber Co., Mechanical Goods Div., 1230 Sixth Ave., New York 20, N. Y. ADV. p 244
United States Safety Service Co., 1331 Oak St., Kansas City 6, Mo.
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W

Wagner Electric Corp., 6401 Plymouth Ave., St. Louis, Mo.
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Weatherhead Co., 128 W. Washington Blvd., Fort Wayne, Ind.
Webb Corp., Box 549, Webb City, Mo.
Webster Mfg., Inc., West Hall St., Tiffin, Ohio
Wedge Wire Corp., Gas St. & N. P. RR, Wellington, Ohio ADV. p 144A
Weir Co., Paul, 20 N. Wacker Dr., Chicago 6, Ill. ADV. p 193
Welch Electric Co., Welch, W. Va.
Wellman Engineering Co., 7000 Central Ave., Cleveland 4, Ohio
Wellman Co., S. K., 200 Egbert Rd., Bedford, Ohio
WEMCO Div., Western Machinery Co., 760-G Folsom St., San Francisco 7, Calif. ADV. p 175
Western Knapp Engineering Co., 766-G, Folsom St., San Francisco 7, Calif.
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Worthington Corp., 421 Worthington Ave., Harrison, N. J.
Wright Hoist Div., American Chain & Cable Co., Inc., York, Pa.
Wright Power Saw & Tool Co., Sub. of Thomas Industries, Inc., 1419 Illinois Ave., Sheboygan, Wis.
Wyssmont Co., 42-01 Q 27th St., Long Island City 1, N. Y.

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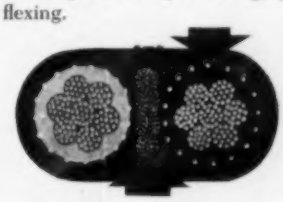

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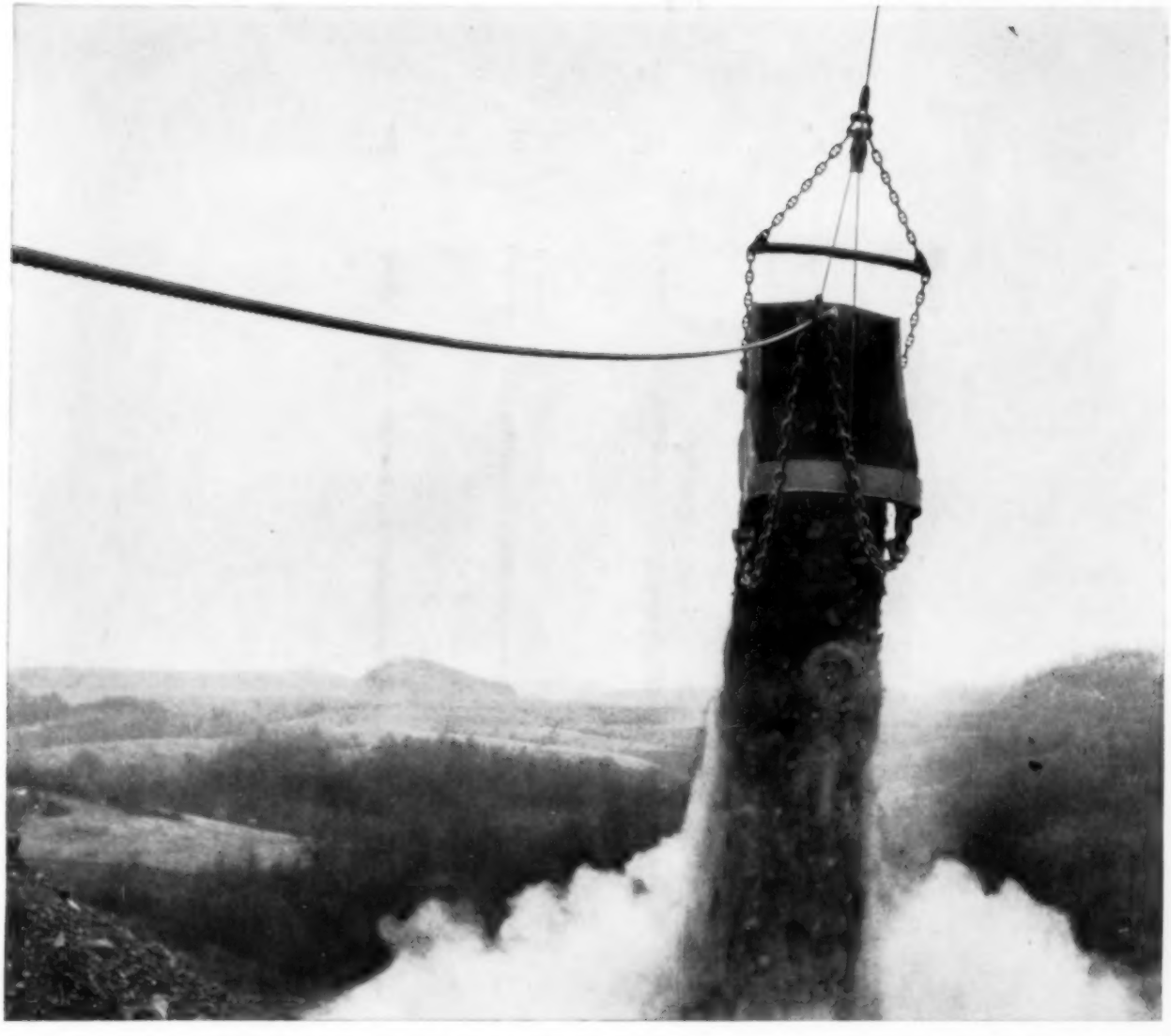

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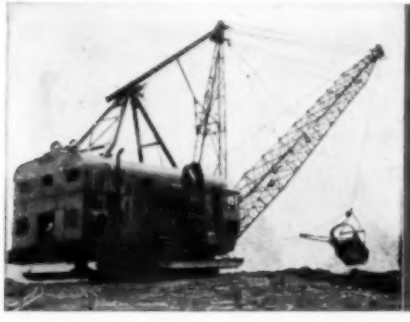

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